THE NATURAL HISTORY OF MIND

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PREFACE

THE reader of this book is assumed to be familiar with recent psychological and philosophical discussion but not with the more obscure subject of recent physiology. For instance I have not stopped to explain what is meant by Behaviourism or Gestalt, but have tried to make it clear what is and is not meant by the nervous impulse and the central inhibitory state.

The first five chapters correspond fairly closely to what was delivered in the lectures, apart from a few sections that were omitted. The rest is much longer and has been altered a good deal, either for better or worse.

The discerning reader will not fail to notice the influence of Whitehead, especially in Chapters I, II, VII, and the first part of VI. In particular I would acknowledge my debt to his *Adventures of Ideas*. I have made few detailed references to him in the text because I have generally avoided his special terminology and am not certain how far my statements correctly reproduce his views. I do not wish to appear to make him responsible for my own peculiar fallacies; but whether or not mine is the true Whiteheadian faith the fact still remains that but for him I should not have said what I have. My debt to Alexander and Stout also is not properly represented by the

references in the text. To other authors I have tried to make adequate acknowledgments by references.

My thanks for their helpful criticism are due to my friends, Dr. R. H. Thouless, who read the whole of the MSS., and Dr. W. Schlapp, who read the physiological part.

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CHAPTER I

INTRODUCTION

It is more than ten years since Professor C. D. Broad published his Tarner Lectures on "Mind and Its Place in Nature." Though neither the character of mind nor its place in nature is likely to have altered much in the interval it is, I hope, allowable to return to the discussion of similar topics.

My aim, as the title is intended to convey, is to see how far it is possible to study mind in a purely naturalistic way; first of all using the physical and biological sciences as far as they will go and then if they do not go far enough in themselves using whatever methods are possible, still within the sphere of natural knowledge. In doing this it is important to avoid two kinds of fallacy, the traditional dualism of body and mind as distinct substances on the one hand and on the other the crude monism that leads either to materialism or mentalism.

It is easy to say "Let us get rid of the dualism of mind and body" and at the present time there are plenty of people who are saying it. But if it is easy to say it is difficult to do. The dualism is so deeply imbedded in thought and language that it constantly slips in and can only be avoided by conscious effort. Up to a point, of course, it is harmless and it provides convenient simplifications which have been useful and are still useful. Obviously we cannot scrap all the machinery of thought that has been built up in the past, we have to try to recondition it.

Like much else both good and bad in our present intellectual equipment, the dualism in its present form originates with Descartes. For him Mind is what thinks; it is the subject, the "I." The objects it thinks about are Matter and the relations of Matter.[1] If the distinction between subject and object is made fundamental it is very difficult to avoid the cul-de-sac of solipsism, as many of Descartes' successors have found. The primary objection, however, is that knowledge comes from considering data and as the subject is not strictly a datum it does not come in at the beginning. Descartes had no business to say "I think therefore I am" before he told us what he was thinking about. In any case it was not the "I" that did the thinking, that was being thought about.

There is a perfectly natural and proper opposition between subject and object but it is not fundamental for knowledge which is the awareness of relations among objects. In any case the object properly includes anything whatever that can be an object of thought, not merely matter, and especially not merely matter as bare extension stripped of all other properties.

Of course Descartes had a strong motive for stripping away the other properties of matter as he did. He had to clear the ground for the science of physics in such a way that only certain questions could be asked and certain kinds of answers given. Above all he had to make it safe from prying theologians. He went too far, farther than his successors could follow him, but he was

[1]Descartes had to make a damaging reservation in the case of God, who was an object of thought and yet not material

For an account of the confusions underlying the Mind-Matter dualism see J MacMurray, *Philosophy*, Vol X, p 264, 1935

unfortunately successful in transferring some of the excluded properties of matter to become ideas in the mind. It is only recently and with difficulty that they have been pushed back where they belong.

Descartes' dualistic theory would not have had such an immense popularity had there not been other influences fighting for him. Present-day "common sense" views of the relation of mind and body, and mind and matter, are derived largely from Descartes but are a mix-up of theories from many sources.

It will simplify matters to go back to an earlier tradition. Mankind has always recognized three main classes of objects; inanimate things, animate things and persons. This distinction has served well enough for the process of scientific investigation up to the present time; we recognize three main groups of study—physical, biological, and human or social sciences. Of course the classification is crude and there are difficulties if it is pushed home too vigorously. The animate group is too heterogeneous and there are difficult cases at both ends. Some things are doubtfully animate or inanimate, some animate things are doubtfully persons. But the classification has the great merit that it is empirically based, does not necessarily involve any metaphysical presuppositions and can be modified as required. In particular we are not bound to the sacred number three It is well to notice that whereas physics may be called the study of matter as such, biology is not the study of life as such, for there is no such thing. It is the study of lives or organisms, that is of those material systems which are organized and living. Similarly there is no science of mind as such but there are sciences that study those special

characters of certain organisms in virtue of which we call them persons. Persons are still material and living, and the study of them can be carried some distance at least by methods not differing fundamentally from those used for the other sciences.

What Aristotle calls the *psyche* is not mind in the sense of the subject as contrasted with its objects. Nor is it simply that which thinks or is conscious. In a sense the *psyche* is simply the life of any animate being. Thus he says that plants have a *psyche* which is capable of nutrition and growth. Animals have these capacities but in addition their *psyche* is capable of sensation and movement. The *psyche* of man has still another function, that of thought or rational behaviour. For Aristotle the *psyche* is the actuality or expression in action of the body belonging to it. As each body differs from every other, so each *psyche* differs because it is the *psyche* of that body and not of another. There is no room for any dualism of body and mind except so far as activity can be distinguished from that which is active. Certainly there is no room for two distinct substances, and that is what the modern view amounts to.

So far Aristotle deals with the subject in a thoroughly empirical and naturalistic manner and so far as this account goes the function of reason is simply the highest of the hierarchy of living functions. But there is another line of thought in his *De Anima*.[1] He says

[1] For instance (413b) "We have no evidence yet about mind (*nous*) or the power to think; it seems to be a widely different kind of soul (*psyche*) differing as what is eternal from what is perishable It alone is capable of existence in isolation from all other psychic powers." J A Smith's translation

A. E Taylor (*Philosophical Studies*, 1934, pp. 245, 246) comments on the

that *nous*, intellect or intuition, is something quite different from the lower functions, is an independent substance, eternal and somehow divine. This view can hardly be based on ordinary empirical evidence from the nature of the case. Presumably his theory was derived from Plato whose psychology is primarily ethical. That is to say the *nous* is that part of us which perceives and aims at the good and is opposed to or insufficiently backed up by the other parts of our being which have no such vision and are, in a negative way, evil. Plato's dualism is the dualism of good and evil. It was taken up by the theologians of the Christian Church and through them survives to the present day mixed up with the Cartesian dualism, though the two theories are hardly compatible because they make the cut in different places.

Plato had other arguments also for assigning peculiar prerogatives to the *nous* and these go back still further. The god Apollo is personally responsible for them for he caused his priests to inscribe upon his shrine at Delphi the precept "Know Thyself." Socrates took this advice seriously and applied it to himself and others with the painful results we all know. An unexpected result was that when Socrates came to consider what it was he was thinking about he concluded that it was

"fault" that runs through Aristotle's philosophy. He says it "... is an imperfectly achieved attempt to hold together a secular or 'one-world' and a religious or 'two-world' view of things The ordinary 'naturalist' is content to see only the one world of the sensible and present; the 'Platonist' is so interested in the 'other' world of the unseen and eternal that his tendency is to come as near as he dares to treating 'this' present world as a shadow or a bad dream For a thoroughly critical philosophy the problem is precisely how to combine aright the two complementary attitudes of frank acceptance of the 'secular present' and the noble 'detachment' which refuses to accept it for more than it is worth."

not the transient flux of things but the eternal and immutable forms which are from time to time imperfectly embodied or shadowed forth in the passing episodes of the material world. Perhaps it was not Socrates who thought this but Plato for him. At any rate the one or the other concluded that the intelligence which contemplates the eternal order of forms must belong to their world. It must be a substance, simple, indivisible, indestructible. The body evidently partakes of the flux: it is complex, transient, perhaps insubstantial.

The body is extended and has inertia like any other piece of matter so that it must obey the laws of motion. It is, of course, a complicated piece of matter but the complications are puzzling and not fundamentally significant so that they are to be neglected as far as possible. The key to the knowledge of mind is to be found in the fact of consciousness, in our awareness of ourselves as conscious subjects and not in bodily organization.

Thus the Cartesian dualism was neatly dovetailed into the Platonic dualism. Although the official psychology of the Roman Church is that of St. Thomas, and therefore is Aristotelian, it has never really penetrated the ordinary thinking processes of Western Europeans, whether orthodox or not.

If I suggest going back from Descartes to Aristotle, I hope this will not be scoffed at as mere antiquarianism. When, as in this case, the Greeks had enough relevant data before them they had a very sure grasp of the essentials; they formulated questions, and suggested answers with a simplicity and directness that is hardly possible in the confusion and tumult of the modern

world. They had their blind spots, of course, like everybody, but what they saw they saw extraordinarily vividly and clearly.

I would urge then that we return to the outlook of Aristotle. Life is the actuality of bodily organization, which is to be studied by the methods of the natural sciences. For this study use the theoretical ground work of physics by all means but do not be blind to any of the facts for the sake of theory There is a hierarchy of living functions. The highest of these are thought and reason, but they are still to be considered as natural functions In order to undertake an empirical study there is no need to decide initially whether or not there is something else present belonging to another world of eternal forms. If duality has to be recognized in the last resort, the dividing line is better placed where Plato put it than where Descartes did, tearing apart the seamless garment of life.

In the end of course the decision has to be made and if I were expounding a full-blown system of philosophy I should have to make it, but in the meantime perhaps I may be permitted to sit on the fence. One remark only needs to be made at this stage. However we look at it, the highest faculties or functions of mind are attained rarely and with difficulty and are precariously maintained, *nous* stands for an ideal to be aimed at even more than a persisting entity. It is much the same for the onlooker whether it is a fleeting visitant from another world or a rare emanation of this world, and it is the onlooker's point of view I wish to take. A dualism of the Platonic type may be open to grave metaphysical objections but it does not stultify inquiry at the outset like the Cartesian dualism.

The study of mind from the naturalistic point of view is the study of the behaviour of human persons in their environment. It must begin by acknowledging that persons are material objects and do not escape the limitations of matter. They are also living and do not escape the limitations of animal organisms. We must start then by deciding what relevant information the physical and biological sciences provide before taking up the specific investigation of mind. The first three chapters of this book are concerned with some quite general considerations arising out of physics and biology which seem to be needed to clear the ground for what comes later. These preliminaries are necessary because it is easy by careless definition and generalization at an abstract level of inquiry to prejudice special developments, to obscure plain facts and even to make the very existence of persons appear to be impossible. In the next two chapters the physiology of the nervous system is discussed. These topics come closer to the subject of the human mind but the results are still mainly negative. Brain physiology, so far as there is such a thing, is a preface to psychology, but is not itself psychology and certainly should not preclude it. Psychology must stand or fall on its own legs. The next subject, therefore, is a discussion of how far and in what respects psychology, the study of the human mind, has special subject matters and special methods distinct from other sciences.

The last two chapters provide the only really positive contribution ; an attempt to sketch out the processes of sense perception and cognition from the standpoint adopted. The sketch is crude and incomplete. The only excuse for it is that the problems involved are

vital for philosophy and are not usually dealt with from this point of view.

Matter and Mind

The general problems of the relation of mind to the world in which it finds itself is often formulated as a problem of epistemology which tends to spread over into the whole of philosophy. Dealt with in this way the problem is to some extent artificial. The mind has been conceived, specially by the followers of Hegel, as primarily and fundamentally cognitive and it has been conceived entirely in the abstract as though born *bombinans in vacuo* and somehow conjuring a universe around itself. Philosophy on this view begins as the theory of knowledge and finishes up as a revised version of the first chapter of Genesis. It is important to counter this view with the opposite one, in itself equally abstract, that mind is a product of the natural world and is still redolent of the pit out of which it was digged. The complete problem has two ends. We can take it from the end of the mind looking out at the world to make what it can of it, or from the end of the world producing minds somehow out of the material available.

Whichever way we look at the matter, minds as we know them are embodied minds (Prof. G. F. Stout's phrase). The alleged exceptions are very dubious and cannot be discussed at present.[1] Mind knows the world and operates on the world by means of its body. It is

[1] This means that the phenomena of " telepathy " by which one mind can influence another without any apparent physical medium must be put on one side. The phenomena are well attested but their nature is so obscure that discussion is hardly profitable yet.

hard to escape the conclusion that bodies existed before minds and minds only exist because there are bodies fit for them.

There are two short cuts to the solution of the problem of matter and mind. One is to deny the existence of mind; but as this is self-refuting it can be ignored. The other is to deny the existence of anything that is not mind. This theory is not self-refuting and in fact is not to be refuted in any simple way. Fortunately there is no need to refute it. Its upholders are either solipsists, in which case we can leave them to enjoy their solipsism, or else they admit that there exists a quasi-material universe (i.e., quasi-non-mental). Whatever it may turn out to be in the end on their theory it is *prima facie* so like a material world that only very subtle philosophers can tell the difference. Those who can tell the difference are bound to supply a code by which any reasonable statement about the real world can be translated into one about the quasi-material world and *vice versa*. So they cannot object to our talking about the quasi-material as though it really existed, at least provisionally.

Let us assume then that there is such a thing as matter which in some cases is not mind also. In making that assumption we are not asserting that matter and mind are distinct substances or that they are different modes of one substance, as Spinoza held.

Vitalism and Mechanism

The age-long controversy between "Mechanists" and "Vitalists" is in part simply that between Optimists, who say that practically everything is

known or very soon to be known, and Pessimists, who say that practically nothing is known. In this respect it is eternal. In part it is a matter of deciding what kinds of concept are necessary and useful in the statement of facts and theories. In this respect it is difficult to see why there should be any controversy at all. Any material system can be described " completely " in a special sense of the word, simply in terms of the positions and velocities of particles. Nevertheless physicists also use conceptions such as mass, electric charge and energy. We do not observe fierce disputes between " Kinematicists " who consider only positions and velocities, and " Dynamicists " who want to introduce such obscure and semi-mystical notions as mass, energy and charge in defiance of the principle of parsimony and to the confusion of clear thinking in science. Nor do we even find disputes on similar lines between physicists and chemists. It would seem that everybody is free to introduce what notions he likes and leave them out as he likes. By limiting the number of notions he uses he may simplify his problem, and that is all to the good, but he may also leave questions unanswered, and that is all to the bad. As long as each decides definitely which questions he wishes to deal with and which he wishes to leave alone, it is purely a question of convenience, or a technical point of method, what conceptions he uses, just as much as what apparatus he uses for his experiments.

It seems reasonable to ask that more and perhaps different conceptions should be used in tackling questions about complex types of material, and equally reasonable to ask that they be used critically if they are used at all.

As Professor Broad and also Dr. Woodger[1] have dealt with the whole matter in an admirable manner there is no need to go into it here at length. Still there are a few useful things to be learnt from the controversy.

First of all there is a quite definite sense in which all information about the material world is mechanical; that is to say it is the result of pushing and pulling things about, and so far must be expressed in terms of their spatio-temporal relations and Mass and Energy and so on. The categories of geometry and mechanics are therefore the most general of all categories of explanation and it is difficult, perhaps impossible, to state any question of interest in terms that entirely exclude them. The very "purest" and most transcendental of human occupations are not exceptions. The mathematician, the poet, the religious contemplative, in pursuit of their mathematics, poetry and contemplation are still concerned to push and pull bits of matter, and nothing we know and say about their activities can be entirely independent of such humble facts. I am not asserting that the mathematician's theorem as he thinks it is a set of physical processes going on inside his brain. That may or may not be true but it is quite irrelevant to the present argument. What I do assert is simply that nobody else can know what the mathematician thinks about his theorem unless he talks about it or writes it down, and that this consists of pushing and pulling bits of matter. You may say if you like that this pushing and pulling has only an arbitrary relation to the theorem itself, the pure

[1] C D Broad, *Mind and Its Place in Nature*, 1925 Woodger, *Biological Principles*, 1929 See also Bertalanffy, *Modern Theories of Development*, 1933, Trans Woodger

object before his mind which cannot be pushed or pulled, because the same theorem may be expressed symbolically in different ways. Still, however arbitrary the relation, some such relation there must be. If the mathematician's thought could be entirely divorced from its expression in speech or writing, then the sailor's parrot who " didn't talk much but was a devil for thinking " may have been wiser than the wisest of men. In this simple and direct way we are all of necessity materialists and mechanists. As a result there is a tendency on the part of those who want to repudiate materialism or mechanism altogether to put in its place a kind of supernatural materialism.

On the other hand, scientific knowledge is always the description of facts and their relations in general terms. It gives us knowledge of practical utility rather than understanding. It does not eliminate mystery it merely puts it neatly away where we can turn our backs on it if we do not like it. In a sense then all scientific accounts are trivial and incomplete. Nothing that science can say will give us imaginative understanding of the individual poet, mathematician and religious contemplative.

Generic and Specific Problems

One of the greatest discoveries of the Greek thinkers was that if you state a problem in its most general terms and find a general solution you have done the thing once and for all and do not need to find a separate solution for each special case. But there are specific problems as well as generic ones, and a generic solution will not (usually) solve a specific problem. Thus it can be proved once and for all that the sum of the angles

of a triangle equals two right angles, whether the triangles are acute, right, or obtuse angled. This solution by itself does not provide any information about the specific properties of right-angled triangles wherein they differ from the others. This may seem desperately obvious, but yet it is often forgotten in the heat of controversy. A great deal of "mechanistic" argument turns on the assumption that the generic solutions of physical problems by themselves solve the specific problems of biology. A great deal of vitalistic argument turns on the assumption that because the generic solution does not solve the specific problem it is useless or false Whereas of course it is necessary to keep in mind that the generic solution merely provides a framework within which the specific solutions must be sought; to arrive at a specific solution at all specific information must be available. It is often possible, though it may be more difficult, to solve the specific problem without knowing the generic solution.

It is a sound rule of method to state a problem in the most general terms by a process of abstraction and to simplify the data as much as possible. When the problem has been solved it is very tempting to assume that there are no further problems and that the data that have been omitted for simplicity's sake do not exist.

The Functions of Theory

A very large part of science is concerned with the actual collection of information, observing things that have not been observed before or have not been observed so fully or accurately. This is so even in the oldest science of physics; in the biological sciences

there is little else. The theories of science seem more impressive than the mere collecting and cataloguing of information but are much less useful really. In fact if theories are treated as objects of worship instead of interesting intellectual toys they are not useful at all.

A theory usually asserts a general relation between two or more variables, such as $f(x) = y$. This means that if any determinate value of x is given y can be calculated. This is called predicting y, and successful prediction is considered the completest test of a theory. It is clear that however perfect the theory, the accuracy with which y can be predicted is never greater than the accuracy with which the value of x is determined by observation. If for any reason x cannot be observed or only observed with a low degree of accuracy the value of the theory is so much lessened. That is to say the value of a theory for prediction, or anything else, depends entirely upon what relevant observations have been or can be made. Newton had to wait for the verification of his gravitation theory until sufficiently accurate data of the moon's path became available.

This is not to say that a theory which cannot predict is useless. It may still be of considerable value for ordering facts and clarifying ideas, but it is not so valuable or complete. There had been plenty of atomists before Dalton and the atomic theory had helped in clarifying the fundamental notions of matter, but Dalton's great contribution was to show that the atomic theory could be used to predict and that it predicted successfully as soon as the relevant facts were obtained. Prior to the development of quantitative chemical analysis there were no facts to apply the theory to. Theories have no value independent of the facts to

which they are applied. If there are no facts, or only vaguely ascertained facts, or excessively complex facts then the theory is of little use. For instance, the phenomena of the tides are explicable by the theory of gravitation and the gravitational attraction of sun and moon on the sea. But the theory is hardly any use for prediction of tidal processes because the facts are too complex. Nevertheless predictions can be made quite successfully on an empirical basis, with little or no theory to help.

We assume that the laws of physics are the universal laws of all material things and we must assume it as a matter of principle, provided we do not fall into the error of assuming that in outline everything is known already and only the details remain to be filled in. Living organisms, however, are just the kind of complex material bodies about which the general laws and theories of physics give us very little information ; very little specific information that is, and it is specific information that is wanted. The great triumphs of physical theory have been among objects on the cosmic scale or the microscopic scale, stars or electrons. Among ordinary macroscopic objects physics is less at home unless they are objects designed for a purpose, machines and instruments. It must be remembered too that the recent sensational revolutions in physical theory are concerned mainly with things on the cosmic or the microscopic scale. On the macroscopic scale of everyday observation they have made little difference.

As far as one can see at present the ultimate units of living organisms are large compared to the atoms of physics and their transactions are governed by what, for physics, are statistical laws. This may turn out

to be wrong but there is nothing known at present to show it is wrong. Whether or not an individual electron is indetermined in any way, a living organism which handles them by the million would hardly know the difference.

Assuming then that we can never admit that living organisms are an exception to the laws of physics and that physical theory as far as it can predict for anything can predict for them as well, what follows? The answer is, very little. We say that living organisms obey the laws of mechanics, of statistical mechanics that is. If you throw a man out of a window it is said that he describes the same parabola as a sack of coals thrown out under comparable conditions. Suppose, for a moment, that he did not. A series of experiments would show what curves he did describe. We should merely conclude that he had some means of propelling himself in the air, and they could be investigated by ordinary physical methods. Things would be a little more complex than they are and possibly a little more interesting but the heavens would not fall.

Experiments have shown that over fairly long periods of time and within the limits of error of the method the human body's intake and output of energy balance one another, as they do in a steam engine. This shows that the human body is no exception to the Law of Conservation of Energy. Suppose intake and output had not balanced; then it would have been necessary to assume the human body possessed some peculiar form of potential energy not previously met with elsewhere. Things would have been more complicated than they actually are, but the matter would have been

open to investigation by ordinary physical methods and again the heavens would not have fallen. Similarly it might have been the case that the Second Law of Thermodynamics, the Law of Dissipation of Energy, was inapplicable to living things. Actually all that can be said is that if there are exceptions they have not been noticed yet. If there are exceptions they will be interesting to investigate, they may introduce some complications into physical theory, they may turn out very illuminating, but again the heavens will not fall.

It might have happened that living organisms enjoyed a monopoly of some chemical element. Actually they do not. They do appear to enjoy a monopoly of certain chemical compounds and of certain kinds of chemical reaction. That is to say these compounds and reactions are not found naturally occurring except in connection with living organisms. Some of these compounds and reactions can be reproduced in the laboratory; some still defy the skill of the chemist; some may always be too difficult for him. But, whether this is so or not, no important theoretical consequence follows; though, obviously, it is easier to get accurate information about what goes on in a test-tube than about what only goes on inside a living plant or animal.

The question as to whether any structural unit, say a molecule of glucose, behaves in the living body exactly as it does in the test tube is one that cannot strictly be answered. There is no difference that can be detected by present-day technique. That is not saying there is no difference at all, only that there is none that can be defined so far.

In fact what seems to be most characteristic and

peculiar about living things is not the kind of elementary units of which they are composed or the kind of physical process that goes on there but the way in which quite ordinary units and processes are combined into organized patterns. The structure of these patterns is specific and of many different kinds. It is from their special structure that their special properties come. General laws and theories are of little help in giving the specific information needed. Each special case must be investigated specially by special methods before one can say anything about it.

It is noticeable, as Broad has pointed out in this connection, that Organic Chemistry, which is the study of certain types of structural patterns among material things, has been pursued as a purely empirical and almost self-contained science, making hardly any use of physical theory at all. In fact the Law of Conservation of Mass is perhaps the only general physical law which is necessary for organic chemistry. If this is the case with chemistry, it is so *a fortiori* for the more highly developed structures that constitute living organisms. Every separate subject matter of science needs its own special discipline and data and may proceed almost or quite independently of general physical theory. But if general physical theory can be used so much the better; it may not provide positive information but it may rule out of account alternative possibilities that would otherwise complicate problems.

CHAPTER II

CAUSATION

It is necessary for the sake of clarity later on to introduce some discussion of the difficult subject of causation. In the first place it must be understood that any particular event is as it is and the antecedent events were as they were. That is all we can say about it by itself and there are no "ifs" and no "because." When we are discussing causation we can deal only with kinds of events and relations between events not with particular events; we can only say that if an event of a kind A is present one of a kind B will follow, and that if A is absent B will be absent. If we know this about some kinds we do not know it about all events. We cannot even know whether or not there are completely "wild" events having no connection at all with preceding events, because they will be merely particular and not of a kind. Miracles may happen, but scientific procedure is bound to ignore them, because *ex hypothesi* they happen in no regular way.

Some time ago Mr. Russell attacked the whole notion of causality[1] His main indictments were two. (1) The traditional notions of cause and effect though possibly useful at the level of common sense and in the rudimentary stages of science find no place in an advanced science, such as theoretical physics, where they are replaced by the notion of functional relations (in the mathematical sense of function). (2) The notion of cause, besides being vague, is commonly

[1] B. Russell, *Mysticism and Logic*, Chapter IX

mixed up with that of human volition, and this he considered a defect.

As to (1). Whenever a law is formulated in mathematical terms it is expressed as a functional relation of two (or more) variables, e.g., $y = f(x)$. Here x is not the cause of y, nor y of x. But, as Russell says, this formula is a propositional function not a proposition. That is to say, as it stands, it does not tell you anything about anything. It only does so when a definite value is assigned to one variable and then it tells you the value of the other. What he appears to have overlooked is that it is just in the assignment of definite values that the traditional kind of causation comes in and that that kind of causation originates in a human volition. This is true of any science rudimentary or advanced. This brings us to (2). From the statement of a general law you infer that if you do so and so, such and such will happen. What you do is a volition from the internal point of view, from the external point of view of physics it is the liberation of energy in your body in such a way that you perform work upon other bodies, you push them about, in fact. This is the traditional sense of causation and as I believe the only proper sense and is applicable throughout the realm of science whenever an act of observing is made. Every observation consists in pushing or being pushed.

Russell rather unfairly draws his examples from astronomy where human volition is notoriously inadequate to alter the course of events; though, as Archimedes pointed out, that is only because we lack suitable apparatus. In any case, I defy anybody to describe an astronomical (or any other) observation without introducing the notion of pushing, the observer must at

least turn his eyes in the right direction. We apply mechanical theories to heavenly bodies we cannot push because we assume they are like the bodies we can, only bigger and farther away. Newton's three laws of motion are the result of observing or assuming (1) that when a body is not pushed it goes on doing what it was doing, (2) that if it is pushed the result varies as the push, (3) that when you push anything it pushes back equally. It is quite irrelevant to point out that in the mathematical formulation of these laws there is nothing about pushing. Neither is there anything about material bodies, and yet material bodies exist and the laws apply to them.

The physicist generally ignores causation, in the sense of volition, because he deals with all bodies except his own body. It is worth noticing however that the statement of Willard Gibbs' Phase Rule involves the notion of number of *degrees of freedom*, which means exactly what it says, the conditions the experimenter is free to vary at will.

Of course if the whole of physics could be transformed from Dynamics, which takes account of Energy and Inertia, into Kinematics which takes account of velocities and acceleration only, then there would be less room for causation, at any rate in the theory. The notion of Causation is bound up with that of Energy.

A simple example will show what is meant. If I have a cylinder filled with air and fitted with a piston, Boyle's Law tells me that when I push the piston in half-way I double the pressure. The primary cause here is my volition or in other words the liberation of energy in my muscles, the effect is to move the piston and that in turn is a cause the effect of which is to

compress the gas. The compressed gas in turn may be a cause. Here is a causal series of events such that each is an effect of earlier ones and a cause of later ones. The cause is what performs work or loses energy, the effect is what happens in the body on which work is performed. The series is extended in time, even though it may be a very short time, for there can be no transfer of energy at an instant. The relation of cause and effect is essentially temporal and only incidentally spatial. The temporal series is not reversible. The volition cannot occur after the gas pressure has risen. In fact it is because causation works one way only that we are interested in it. If the future did determine the present, action and purpose would be paralysed.

Consider now what happens if I hold the piston steady against the gas pressure. My volition and my muscles are still active, but nothing is happening outside my body. I am not performing work but merely getting hot dissipating energy. There is now no causal series in the same sense, there is no transfer of energy to or from the gas, no change of spatial relations. I can equally well clamp the piston in place and stop exerting myself. In a static system where there is no change with time there are no relations of cause and effect as between different parts. But it is customary to extend the notion of cause and effect to static systems by treating the total state of the system in the immediate past as the completely determining cause of its present state. No energy is transferred from one thing to another but the total energy is passed on from moment to moment within the system. This may be called *Immanent Causation* as opposed to *Transeunt*

Causation. Clearly in every case of change there will be in operation, immanent causes or stable conditions as well as the more conspicuous transeunt causes.

Suppose I have a vessel containing an explosive mixture of oxygen and hydrogen, by closing a switch and making an electric spark inside the vessel I may explode the gas. The first event in the causal series, closing the switch, is trivial from the point of view of the amount of energy liberated, whereas the explosion may liberate a very large amount of energy and produce the most dramatic results. In tracing out a causal series it is necessary to consider not so much the quantity of energy liberated as the time sequence and the standing stable conditions which determine the direction and final results of what transfer of energy takes place.

It is customary to call the spark the cause of the explosion although if I make the spark in a vessel of air nothing will happen, and really it is the whole complex of the spark in a vessel containing an explosive mixture that is strictly entitled to be called *the* cause. But the common way of speaking is quite reasonable in so far as it emphasizes change in the system rather than the unchanging stable conditions.

Isolated Series

For causal relations to be simple they must take the form of an isolated series. That is to say, one event not too far extended in space and more or less homogeneous must succeed another similar event in linear succession; and if there are several lines of succession they must be parallel, or such that they can be treated as parallel. A billiard ball rolling over the table is for practical purposes a simple isolated series, although

strictly it is not simple or isolated. Any one part of the ball follows a complex path and one different from that of its neighbours but for many purposes the whole ball is like a massive point occupying its centre. The ball is pushing against the table, but as this push is uniform it does not alter those horizontal movements to which the ball is restricted Again there is friction between the ball and the table and the ball and the air, but for short times and rapid motions this can be neglected. Thus in this case, as in others, where the actual total situation is very complex it is possible by analysis and abstraction to find a more or less simple isolated causal series which is capable of being investigated as such. By neglecting small causes, by abstracting from stable conditions which are not relevant, by considering that spatial unit which has the simplest relations, and so on, it is possible to consider the billiard ball as a single massive point moving freely and conserving its momentum ; it will then form a simple isolated causal series.

There is, however, another condition to be fulfilled to obtain any simplicity and regularity, there must be spatio-temporal continuity between cause and effect, as Broad has pointed out. If you throw a stone at a bottle, it is only in a very loose sense that throwing the stone is the cause of breaking the bottle, even assuming your aim to be infallible. After the stone is thrown many things may happen, the bottle may be removed, a board may be put in front to protect it, so that the stone never hits it. To obtain uniformity and simplicity in causal relations the series must be treated microscopically ; at any rate no large gaps must be admitted. If there is a gap in space and time between

a cause A and an effect B, we must be able to fill it in with uniform or continuously varying intermediate events There are of course logical puzzles involved in this notion of spatio-temporal continuity and also physical puzzles when we come to the most microscopic transactions. Quite possibly there is no such thing in a strict sense. Nevertheless it is obviously possible both in theory and practice to reduce the gaps to sufficiently small dimensions for all ordinary purposes of observation and experiment.

Complete and Partial Determination

With these preliminaries in mind consider the possible relations between two kinds of events A and B which are spatially and temporally continuous (or nearly so) and of which A is earlier than B.

The possibilities are :—

(1) A and B both occur.

(2) Neither A nor B occur.

(3) A occurs, B does not.

(4) A does not occur, B occurs.

If (1) and (2) apply and (3) and (4) do not then we have the simplest and completest case of causation, or Complete Causal Determination. Philosophers and others have often assumed that the whole universe is such that it is completely determined in all its parts in this sense, and some seem to have assumed also that knowledge would be impossible if this were not so. This last assumption is certainly false. The other is to say the least "not proven." Actually any isolated causal series will be completely determined in this sense as long as it is isolated, but not otherwise. As long as the stone is flying freely each state is completely

determined by the immediately previous state of the stone, but as soon as it hits the bottle this is not so. The series is no longer isolated and therefore is not completely determined internally though it may be externally determined, i.e., what we know about the stone is not enough but what we know about the stone and the bottle may be enough, to tell us what is going to happen. There are sets of events which are not known to be *completely causally determined*, but they may be *partly causally determined* in the sense to be defined.

If (1), (2) and (3) apply and (4) does not then we have the ordinary law of causation used by common sense and in scientific investigation. A is a part cause of B, if B never occurs without A preceding, though A may occur without B. Turning over the engine of a car is part cause of starting it, because it will not start unless it is turned over. But turning it over is not enough to start it if the ignition is switched off, or any one of the many other necessary conditions is lacking.

Nobody doubts that this kind of *Partial Determination* is met with every day and is the basis of all rational behaviour.

There is thirdly another possibility, (1), (2) and (4) might apply and (3) not. This would be *Plurality of Causes*. For instance if you eat arsenic it kills you (1). If you don't eat arsenic you may be killed crossing the road (4), but on the other hand you may go on living for a time (2). It is however false that if you eat arsenic you go on living (3 false). In this case it appears that B (death) is caused not only by A (arsenic) but by A_1 and A_2, etc., also. Those who have tidy minds always want to deny plurality of causes and to

say that further analysis will reveal that the effect of A_1 is really B_1 and not B. They will point out that death by arsenic poisoning is a specific kind of death very different from death in a street accident, so that strictly it is a case of complete determination. Where this point can be proved the matter is of course greatly simplified, nevertheless it seems to me a mistake to assume on principle that there can be no such thing as Plurality of Causes.

There is a last possibility to consider, that (1), (2), (3) and (4) all apply. This might be considered as Indetermination pure and simple, or else a special case of plurality of causes, *plurality of part causes*. In such a case knowledge would be difficult to attain but there is no reason to suppose it would be impossible. It is precisely this kind of case that is dealt with by statistical methods. On the other hand it is not easy to see how mechanical explanation can be applied to such a case. If we found not only that car engines may refuse to start when they are turned (as they sometimes do) but also that they start without being turned, it might be possible by statistical methods to predict what were the chances of any given engine behaving in any given way, but we should have to give up the ordinary mechanical ways of explaining their behaviour and we certainly could not design an engine to behave in this way. If this is causal indetermination then there seems to be no reason to suppose that there are no undetermined processes going but simply that it will be difficult to find out much about them. In practice they will tend to be ignored and attention be concentrated on determined processes.

In conclusion, Partial Determination is a fact and an

important one, but one cannot say whether or not everything is determined in this way. Complete Determination is also a fact in certain simple cases. The more we can reduce our cases to this type the better equipped we shall be for knowledge and successful activity.[1]

It is now possible to state some fundamental propositions and make some definitions.

(1) *An event of type A is related to one of type B as cause to effect if B's are preceded in time by A's and never occur in their absence.* An A is called a *causal predecessor* or *part cause* of a B.

(2) *Simultaneous events are causally independent.* This important proposition has been pointed out by Whitehead[2] who also points out that it is the reason why spatial relations are treated as external.

It would be possible, I believe, to deny this proposition without manifest absurdity but it would make the treatment of causation very difficult and would obliterate the distinction between space and time. If the facts of telepathy are as alleged they would constitute an exception.

We are intuitively aware of simultaneity (approximate) in our immediate neighbourhood but we have no such intuition about distant places and can only find out by the help of this rule and the use of causal series as signals. But in such a case there is always a certain

[1] I have avoided the use of the term "Determinism" because I object to the "ism" not for any other reason It seems unnecessary to make a metaphysical first principle out of a useful rule of method But if "determinism" is mildly objectionable "indeterminism" is absolutely vicious It has evidently originated as a protest against the theory that nothing new ever happens

[2] *Adventures of Ideas*, pp 251, 259

margin of uncertainty set by the time taken for the signal to travel. In practice this rule is not as useful as it might be because our time measurements are rather coarse and some causal series are propagated with great speed, so that there is very often uncertainty as to whether two series are really simultaneous and independent or perhaps causally related. This difficulty crops up in connection with processes within living organisms.

(3) *Events distant in space and time are not causally related unless there is a continuous series of causally related intervening events.* This has been discussed already and though there may be difficulties about this use of "continuous" I think the meaning is clear enough.

(2) and (3) together deny action at a distance. The history of physics shows that this denial is not pure prejudice but is necessary for the statement of causal laws. The notion of action at a distance is not repugnant to common sense, at least not to prescientific common sense, because magical practices often assumed there was action at a distance. As to human volition, the type cause, it is clear that there is no action at a distance. (Telepathy may be an exception, but it might be propagated by an intervening causal series of some sort.)

If a causal series has no appreciable spatial extension or is spatially homogeneous it is *simple.* If each event has only one immediate predecessor and one immediate successor, or in other words if events neither *converge* nor *diverge*, it is an *isolated series.*

(4) *In a simple isolated series all events are similar.* In this case and this only *causa aequat effectum.* Perhaps it is as well to add a last proposition.

(5) *If any two events anywhere are similar they have some similar predecessors and if different some different predecessors.*

If two series are parallel they are causally independent. If they diverge then they have common predecessors, are not causally independent and show some kind of order or similarity based on common origin. Light radiating from a point source is an instance of divergent series. One's total sensory field is an instance of convergent series, so also is a collision between two motor cars.

If convergent or parallel series were originally divergent they are not strictly causally independent. It is conceivable that the whole universe is the consequence of one unitary act of creation so that all separate causal series are originally divergent and it is also conceivable that the whole universe is sufficiently simple and orderly for all series to exhibit some similarity of pattern. If this is so there is no such thing as true causal independence. But this doctrine is not very plausible or helpful. If I am simultaneously stung by a wasp and hear the telephone ring, I cannot as a matter of fact discover any causal connection between the two events. To say that they are both inevitable consequences of the primal act of creation of the universe may be false and even if it is true provides no information of any value. A living organism in so far as it has developed from a single cell is a divergent series, so that it contains simultaneous events which are not causally independent. The organism does not consist wholly of these as it is also a focus of convergent series.

Prima facie then there are convergent causal series

which are independent, so that no amount of information about the one can tell us about the other. If prediction is possible as to what happens when they converge it is because we have information about both series at once and have discovered the law of composition for their convergence.

Take a very simple case. A perfectly elastic billiard ball (A) collides with a stationary one (B) hitting it fair in the middle. A is brought to a standstill and B shoots off with the same speed and direction as A. The law of composition here is perfectly clear and simple. The theoretical physicist considering this case is apt to say that nothing new has happened; *causa aequat effectum*, momentum is conserved, one ball is as good as another. This is like saying that when your pocket is picked nothing new has happened because the money is still there in somebody's pocket. From the point of view of ball A something new has happened because it is now stationary, its momentum is not conserved; so also with ball B. There is nothing in the past history of ball A to tell us it is now stationary and nothing in the past history of B to tell us it is now moving. From the point of view of the individual balls it is sheer unpredictable novelty. The physicist ignores this. He is on the look out for conservative systems in which nothing new happens and simply selected his facts for this purpose.

It may be true that if we knew all simultaneous events and all the laws of composition of converging series we should be able to predict all future events. But then we should be omniscient and we should not need to predict; obviously a being who knows everything at any time by mere inspection is equally capable

of knowing everything at all times by mere inspection. The problems we are faced with all turn upon how by a partial inspection and incomplete information to predict something about what is going to happen.

Convergence

Whenever two causal series converge something new may happen. It is a definite beginning, so that, although the world consists of an indefinite regress of causes, we can nevertheless discuss causes intelligently without having to start from the Creation. In the case of the billiard balls, to discuss the collision and its results it is enough to know the position and velocities immediately before. The previous history of the billiard balls can be left out of account, as it cannot provide any additional information relevant to the collision. Similarly on the other side, if a series can be traced back to a region of divergence, it is seldom of value to trace it back further. If we cannot ascertain by direct observation the character of the series after it has diverged it is unlikely that information about what happened earlier will give us any precise knowledge of that series. It may give us some information by means of which we can predict roughly what is going to happen. If we knew the properties of hydrogen and oxygen but had never come across water we could predict that if they combined the compound would be roughly the sort of thing water is but we could hardly predict its properties completely or accurately. One might say *convergence* is *emergence*, to use a now popular term, without any serious exaggeration. I should be inclined to go further and to say that where there is convergence without order there may be

indetermination (for all we know). Where there is convergence with certain kinds of order there is freedom. The peculiar character and structure of the animal and specially the human body is an order designed to that end. The difficulties in the way of dealing with them from the causal point of view turn upon the fact that they are centres of perpetual convergence and divergence.

Freedom always means activity, spontaneity, or internal determination as opposed to passivity, inertness or external determination. The essential character of a living organism from this point of view is that it possesses a supply of potential energy which can be liberated through a controlling mechanism and appear as kinetic energy. Potential energy is a scalar quantity but kinetic energy is a vector quantity. The directional component is not determined by the quantity or kind of the potential energy but by the machine or organism through which it is converted to kinetic energy (or some equivalent of a vector type such as an electric current). The direction can be altered by the expenditure of strictly minimal quantities of energy on the controls of the machine. The amount of energy required to drive the *Majestic* is very large, this is supplied by the engines ; a good deal is needed to hold the rudder at an angle, that is supplied by the steering engine ; the man at the wheel who twirls the spokes only needs a minimal expenditure of energy to steer the vessel. Therefore as long as the engines are running and the steering engine is working, but no longer, he is free to steer the vessel where he likes.

The man at the wheel is not only a cause he is also an effect. He is a place where many causal series converge

and they are of the peculiar type called stimuli. That is to say some produce no final effect, some do, and he is able to select from among competing external causes. Thus if the navigating officer tells him to alter his course he alters it, if some unauthorized person tells him to he pays no attention.

It is important to remember that freedom has no connection with indetermination nor with our ignorance of how determination comes about and it is not incompatible with prediction. In fact we cannot predict what course the ship will steer unless we assume the freedom of those in control. The ship's course however is not predetermined at the start it is determined from moment to moment by changing circumstances and the navigators' volitions, but given sufficient information about these volitions and about the relevant physical conditions we can predict with as much certainty as we can about any complex physical system, even where there is no freedom and no volition.

Admittedly there are grave difficulties in the way of considering freedom, but I believe they are mainly the result of vicious habits of thought. The first is the notion that freedom implies indetermination. The second is that the effect ought to equal the cause always and that where it appears not to the appearance must be explained away as due to ignorance of causes. As against this I would urge that freedom is a consequence of certain kinds of determination and where there is convergence the effect hardly ever equals the cause. Lastly there is the notion that to say we sometimes act freely, implies that we always do, which is of course quite false.

Microscopic and Macroscopic Processes

It is clear that what has been said about causation applies to large scale processes at the level of direct observation and not to microscopic processes at the level at which the Quantum Theory applies. As soon as we come to consider minimal events in nature special characters and relations (and special difficulties) are bound to crop up which are invisible on the large scale.

Although all information about microscopic processes is a theoretical construction based upon large scale observations, there is a tendency among theoretical physicists to attribute a higher degree of reality, certainty and precision to the laws of microscopic processes and consider that regularities among macroscopic processes (which are often statistical) are somehow not quite genuine. It would be impertinent for an outsider to intrude upon what are purely technical and departmental questions as to the relation between microscopic and macroscopic laws and the puzzles that arise when microscopic theory is pushed to its limits. But there is one point that must be insisted on. The macroscopic laws obtained by observation cannot be dismissed as fictions or as " merely " something else. Granted that air consists of particles in random motion, nevertheless when a tuning fork is set vibrating the air conducts wavelike processes of (within limits) perfect regularity of form as can be seen from their effect on suitable resonators. That regularity is statistical from the microscopic point of view but there is nothing " mere " or fictitious about it. It is a genuine large scale order impressed upon a random aggregate and capable of being impressed just because initially the

aggregate was random. The process of transmission is causal in as strict a sense as you like and just as much so as if a completely ordered microscopic system underlay the macroscopic system. There is no reason to be afraid that what at the macroscopic level is discovered by observation to be regular and causal can be somehow explained away by microscopic theory as accidental and really not regular or causal.

CHAPTER III

LIVING AND LIFELESS

THE distinction between the living and the lifeless seems clear enough while it is the higher animals only that are being thought of. Between a dog and a stone there is obviously a great gulf fixed which seems well described by calling one living the other lifeless. But if one considers the whole realm of nature and the whole variety of forms exhibited it is seen that this simple dichotomy offers fundamental difficulties. The difficulties are similar to those that follow from classifying mankind into golfers and non-golfers. How often and how well must a man play to qualify as a golfer? Are caddies golfers? Is there any other character peculiar and common to golfers which would make the distinction useful?

It is easy to decide when a dog or a man is alive and when he is dead for legal purposes. There are certain characteristic activities such as breathing which all dogs and men display at all times, others which they display at some time, such as growing, and which no dead dog or man or lifeless thing ever displays. On the other hand from a legally dead dog or man tissues and organs can be removed and can go on displaying all their characteristic living activities in spite of the death of their original owner. The higher animals are in a sense a society of living organisms. They have all originated from a single cell but they are actually composed of what are to some extent independent living units. These units are specialized and co-ordinated

however, some display one characteristic activity in a high degree, others in a lesser degree, and they cannot carry on independent existence for long without special care being taken of them. The most primitive organisms appear to consist of single cells rather like the constituent cells of higher organisms but still more like the original single cell from which these have developed.

In spite of all divergences it seems safe to say that to be reckoned as living an organism must (*a*) be the seat of certain kinds of chemical reactions associated with the liberation of energy, (*b*) develop and maintain a characteristic structure and (*c*) be capable of multiplication or have been capable of it. Even then we find that cell fragments, and even things that cannot be more than complex substances in solution liberated from cells, carry on some if not all of these chemical reactions. There are bodies too small to have any visible structure that not only carry out characteristic chemical reactions, but also multiply indefinitely. In fact among the lowest organisms hard and fast distinctions between living and lifeless cannot be drawn.

Difficulties can be avoided as soon as it is realized that no simple definition of the term living can be given and that it has no precise denotation. There are as great differences between different kinds of living things as between living things and lifeless. The difference between living and lifeless is better treated as a matter of degree. Some things are deader than others, some things are livelier than others. All the things that have any claim to life are organized or ordered systems. There are hierarchies of organization. At the lower levels of the hierarchy there is less difference between living and lifeless than at the higher

levels. To treat of the higher levels, conceptions and methods of study of small importance or relevance at low levels need to be employed.

Organization

As I am not prepared to define what is meant by *organization* or by *order*, I shall have to assume that the meanings of these terms are clear. It is easy enough though to give illustrations of what is meant by order. The snail's shell, which is a logarithmic spiral, the symmetry of a flower or a freely growing tree are examples, but so also is the assymetry of a tree growing in a cramped position or exposed to a prevailing wind. The order is even more striking if we consider not merely the spatial order at an instant but its development throughout life, the four dimensional geometry of the organism. The snail's shell provides a simple illustration because the form of the shell at any time is the projection in three dimensions of the history of its growth process up to that time. While order is visible in the whole it is also visible in the parts and in the underlying chemical processes which bespeak a molecular order beyond visible limits. It is such a hierarchy of orderly structure and process that constitutes a living organism.

Histories

So far nothing has been said that need offend the susceptibilities of the most sensitive Materialist or Mechanist. Living organisms are special cases needing special study, their chemistry and physics is difficult and complicated but it is just chemistry and physics. Now comes the question that shocks the Mechanist; why are they special cases? Living things are complex

and unstable, how have their complexities and instabilities arisen? The inorganic world tends to go from the unstable to the stable and does not tend to go from simple to complex or from chaotic to orderly unless the simple and chaotic are less stable. How is this process reversed?

Suppose I take two pots of sterilized moist earth and put living seeds into the first and boiled seeds into the second and keep them exposed to light under sterile conditions. Nothing much will happen in the second except a little heating and cooling, but in the first plants will grow and there will be a very slightly less heating and cooling. Living seeds are chemically complex and are unstable as shown by the fact that slight chemical changes are always going on and a little heat is being liberated. When they germinate they become more unstable, more heat is liberated and the chemical changes are more rapid. As the plant grows the quantity of complex unstable chemical substances increases and there is still more chemical change. In some of the changes heat is liberated, in some it is absorbed; on the balance rather less energy goes to heat in the first pot than in the second, though more complex energy changes are taking place. The boiled seeds are not very different from the unboiled except that no measurable chemical changes occur. There is nothing in existing physical theory to suggest why with the unboiled seeds an unstable system should tend to increase at the expense of stable systems. The growth of the plant is not contrary to the Second Law of Thermo-dynamics because in all the energy exchanges there is dissipation in the form of heat as the law predicts; it is simply that there is a little less than

there would be in the absence of the plant. From the point of view of physical theory the growth of the plant is a brute fact merely, not contrary to theory (or the theory would be false) but on the other hand quite unexpected.

If it is admitted that the physicist cannot account for the difference between a dead seed and a living one, can the biologist? He can, to some extent, not in terms of physical theory, but in terms of history. He considers not only the physical make up of the seeds at the moment but their history, past and future. A living seed is something that was grown on a plant of a certain sort which grew from a similar seed, and so on as far back as you like; it is also something that can grow into a plant of a certain sort to produce similar seeds, and so on as long as you like. A dead seed has a similar past history but no future history. The seed or the plant is a term in a life history or rather a succession of life histories and is only intelligible in terms of what goes before and after.

The conception of an organism as a strand of history is not incompatible with physical theory but it is a kind of conception that physical theory has neglected in the past, and neglected for quite sound reasons. It was assumed that the units of physics had no history because they were eternal. This assumption as far as it is valid introduces important simplifications but its validity is limited even in physics. A wave system has a history; you cannot have a wave at an instant or at a point; it fills a finite spatio-temporal volume.

The indestructible and unchanging entities of physics are not strictly eternal but are strands of history so long and so monotonous that their history as such can

be neglected and we can attend exclusively to forms and qualities that belong to them throughout. These forms and qualities are abstractions and are useful for knowledge for this very reason that their relations are simple and external. An atom (unless it is radio-active) is the same at any instant, so it has no history worth mentioning. Everything important about it can be stated in terms of external spatial relations to other atoms at any moment. Its title to be considered *an* entity depends upon the unity and simplicity of its relations.

A living organism is a process occupying space and time. Change is of its very essence. It has a beginning and an end and in between it is either growing or decaying. To say that there is nothing new in growth, that the chicken is preformed in the egg, on the grounds that all change is merely a shuffling of pre-existing parts is ridiculous. It is the shuffling process that is the organism. If this has unity, order and some simplicity of relations it has as much right to be considered *an* entity as a physical atom The fact that it does not last so long is immaterial.

It may be said to be obvious that living organisms can only be considered adequately when they are treated as strands of history. It is not so obvious that lifeless things must be treated as strands of history but it would appear to be a point of view that is entering into physical theory and that nowadays physics can continue to neglect it only at the cost of giving up the possibility of solving some of its problems. That is to say this notion does not mark a dividing line between biology and physics. What does perhaps mark a dividing line is the peculiar fluidity of the histories of living organisms. If external circumstances deflect the

pattern of an organism from its normal course there is a *tendency* for the organism to restore it as far as possible and to restore it very often in a novel way. If the leading shoot of a tree is broken off, the whole growth process may be deflected so that a new kind of symmetry is developed, still characteristic of that kind of tree yet quite distinct from that of unimpeded growth This *tendency* cannot be described except as a kind of aim or striving—in a word—it is teleological.

There is one last point about histories As long as a history can be divided into a series of instantaneous cross sections and these differ only in the spatial arrangement of persistent units everything is easy As soon as the history is dealt with as a whole the difficulties are greater. Yet it is just this fact that from no single slice of history or set of slices can a complete account be given that makes the whole history an individual The individual cannot be less than the whole history ; it is what pulls together and limits the otherwise interminable and indistinguishable processes of the physical world.

Teleology

It is generally assumed that man is a more highly developed organism than the amoeba, although, as Russell has remarked, we have never heard amoeba state his case Nevertheless there seem to be rational grounds for the assumption. It is not only that the visible structure of man is more complex, more highly articulated and more integrated. That alone might be deceptive. The amoeba might possess extremely complex invisible structures, while the corresponding invisible structures in man were simple and elementary.

In fact some geneticists have played with this notion. Their views I believe are quite unsound and their arguments easily refuted,[1] but that is not the point here. I mention the matter simply to show that confirmatory evidence is needed before we can accept visible structure at its face value. There is plenty of confirmatory evidence in this case. It is this, that functionally man is more complex, he can respond in more different ways, his response is more flexible and more delicately adjusted to changing situations, he is more independent and spontaneous, less at the mercy of adverse circumstances. There is good reason to believe that visible structure and function go together, so that the one can tell us something about the other.

In considering an organism from the functional point of view as a process of responding to what is going on round it, it is impossible to avoid the use of terms such as successful or unsuccessful, adequate or inadequate, well adapted or ill adapted, normal or abnormal. All such terms imply the notion of purpose or teleology. It is true that some writers of the extreme "Behaviourist" or "Conditioned Reflex" schools ostensibly eschew such notions, but they always come in again sooner or later in a disguised form and are none the better for the disguise. The central fact about living things is that they appear to try as hard as they can to go on living. When they die it is for lack of means, because the machinery fails, rather than for lack of will This apparent fact is perhaps the one characteristic distinction between the living and the lifeless Is there any reason why so many have been so eager to deny this fact or to try to explain it away? There

[1] See Woodger, *Biological Principles*, pp 408–428.

are perhaps three reasons. The first is the notion that purpose implies indetermination, this has been discussed already and may be dismissed. The second is that the assertion of purpose or design has been treated as an explanation whereas it is not an explanation in the ordinary sense but a statement of fact, or a description, which may or may not be capable of explanation. This remains as a valid objection to rash statements about purpose. The other reason, which is wholly fallacious, is the supposed incompatibility of purpose and mechanical theory. There is a certain irony about this notion because our ideas of purpose and design are largely the outcome of man's mechanical manipulation of matter to suit his own purposes. A tool or machine is simply something that has been constructed and that operates according to mechanical laws *for a purpose.*

It is worth considering the character of machines for a moment. (1) It is only by knowing and following the laws of mechanics and the other laws of physics that a machine can be made and got to fulfil the purpose intended. (2) Given the relevant knowledge of laws the behaviour of the machine can be predicted in certain circumstances and within certain limits, but the setting of these circumstances and limits is not a matter of mechanics or physics but of human volition or purpose, that is to say of the factor of Control or Freedom. Thus from the laws of physics it can be predicted that *if* the engine of a certain car is running, *if* the throttle is so much open, *if* the top gear is engaged, and *if* it is steered along the road and kept from colliding with anything, *then* it will go at such and such a speed. But starting the engine, opening the throttle, engaging the gears and steering the thing are the consequences of

human control and so is the whole contraption itself. The acknowledgment of this controlling factor is not mere ignorance, no amount of information about the laws of physics would remove it. It is conceivable that specific and detailed information about the physical processes inside a man's body plus a knowledge of relevant laws would enable us to predict accurately how he would utilize his power of control or freedom in a given case. That would constitute an explanation of the acknowledged fact of freedom, it would not explain it away. It so happens we cannot explain it and this is made an excuse for trying to explain it away.

The third point about machines is that their purpose is external and belongs to the men who make and use them. All the parts might be used for something else, they are intrinsically neutral. This is a fundamental difference between living organisms and machines. The purposes of living organisms are internal and the parts are not intrinsically neutral. The organs of your body are your organs, there are no spare parts to put in their place (except for quite minor repairs).

To sum up: there are two questions to ask about a machine. How does it work? and Why does it work? or What is it for? The answer to the first is a matter of physics, the answer to the second is a matter of teleology. There is no contradiction between the answers; they are simply different; one is concerned with means the other with ends. You may know one without the other. Complete knowledge means knowing both answers.

Some of the parts of living organisms bear a very striking resemblance to machines. To take the most obvious case, the eye is an instrument for the purpose of seeing. It is an instrument very much like a camera

from the point of view of optics and to discover and explain how it works is purely a matter of physics.

But what about its purpose? In the case of human eyes it is easy, we know why we use our eyes. Further we can investigate how far the human eye is adequate for its purpose. What is called the *normal* eye is not the average eye or anything like it. It is the eye of maximum efficiency for discriminating objects and is actually rather rare. Just as in engineering, the investigation of efficiency is a matter of physics, but the notion of efficiency has nothing to do with physical theory, for which it is a meaningless ratio. Its only significance is in connection with the purpose of a machine or organ.

When we come to consider the eyes of the lower animals which are very different from human eyes we are in a difficulty. The structure can be described as a matter of geometry, but what the animal does with its eyes we can only guess at, using as far as possible the analogy of human eyes. In fact this is the real difficulty of teleology that we know directly of no purposes but human ones, and when we speak of design it is human design that is thought of. We can say that the organs of an animal's body function as though designed for a purpose and appear to fulfil its purposes if it has any. But there is always some doubt about its purposes and whoever designed the organs it is not likely to have been the animal itself. Even when we are certain about purposes, as in our own case, a teleological statement is a statement of fact and is not an explanation, if by explanation we mean a general description of effects in terms of their causes, as we nearly always do.

In fact it is always possible to give a coherent account of any thing or process without mentioning purpose

even though such an account may be trivial, in the sense of ignoring questions that are relevant and important. Playing the violin can truthfully and coherently be described as rubbing the entrails of a dead sheep with the hairs of a dead horse, but the account is trivial unless the performance is very bad. We can give a coherent account of the crime without mentioning the motives of the criminal. But, as every reader of detective stories knows, the motive is an important part of the evidence and the account that leaves them out may be justly condemned as trivial. Where, as in the case of the lower animals, we cannot be sure about the motives the indictment of triviality may be true but not so easy to bring home.

Let me give an illustration. Among the organisms that live on the sea shore different species are to be found living separately in different zones, some high up where they are seldom covered by the sea, others low down where they are seldom uncovered, others still in the middle where they are covered and uncovered at every tide. The various species of winkles (the animals that are eaten with a pin) are a good instance. Now you may say if you like that each species *chooses* to live in its particular zone and not elsewhere. Or on the other hand you may say that the apparent choice is the result of natural selection. Any individual winkle that happens to stray out of its natural zone dies and leaves no descendants, whereas those that do not stray live and leave descendants. This is an explanation in terms of causes and life histories. But still it remains a fact that the winkles are to be found in that zone and it is quite legitimate to say they *choose* or *select* or are *adapted* to that zone.

If you take a number of winkles of a species that live low down on the shore and put them high up and others that live high up and put them low down, you find that they wander off aimlessly in all directions so that a few reach their proper zone and stay there, many more do not reach it at all. At this point in the narrative the anti-teleologist crows triumphantly and says " I told you so ; it is all the operation of blind mechanical forces; there is no choice or purpose about it at all." But he is wrong. If you were to put a number of men separately in boats in a fog and out of sight of land and each other, they would row aimlessly in all directions, some would get ashore but many more would not. Does that prove that they do not want to get ashore and that they are devoid of choice or purpose ? Of course not, it only proves they have no means for finding their way, so that their purposes fail to come off. It proves, not the absence of purpose, but the absence of adequate machinery to make the purpose work. Knowledge is simply mental machinery and what the men in the boats lack is the knowledge of which way to go and a mechanism of orientation (a compass) to keep them going that way. The winkles are in exactly the same predicament as the men in a fog, there is nothing to tell them which way to go. For all we know they may " want " to go home as much as the men do. Certainly when put into an unusual habitat the animals appear to be " uneasy " ; they tend to wander away (is this describable without teleological terms ?). That is as much as their machinery enables them to do.

Even where we have some knowledge of purposes and can predict from it the predictions are not so certain as are predictions from causes. We tend to use causal

arguments as far as we can and only bring in teleological arguments where causal information is lacking. This leads to the notion that they are somehow incompatible and that teleological arguments are something to be ashamed of. We are compelled to admit purpose and freedom of action for ourselves and out of common decency for other people but we are reluctant to concede the same privilege to the lower creation. We allow that a man walking along the streets is free to turn left or right as he wishes and that his course is not predetermined. We are reluctant to admit that it may be true of a winkle walking along the beach. In his case when causal information fails, we have still one unfailing resource, we can always introduce probability, which is another name for ignorance. We can take a thousand winkles and find which way the statistical mean winkle will walk.

Wherever the method of experiment is used the question set and the answer given is in terms of causes. This follows from the nature of an experiment which is a deliberate interference with causal processes. It does not follow however that causal concepts are the only ones admissible. The engineer finds the efficiency of an engine by measuring its fuel consumption and its output of work under various conditions, an operation making use of physical laws and methods and causal processes. The conception of efficiency is expressed in physical units but it is purely teleological. It has no significance apart from human purposes, as is seen from the use of the term " useful work " in defining efficiency.

It is perhaps worth emphasizing that if we take up the teleological point of view, the causal or physical account is not thereby reduced to irrelevance. Quite

the contrary, both are necessary, as the example of the winkle shows. It is no use having a purpose unless there is a mechanism to make it effective. This is a point the teleologists are apt to forget. They assume that given a purpose it is bound to be fulfilled somehow or other and the mechanism does not matter—this is sometimes called Idealism. For this reason I should quarrel with the much quoted dictum of Prof. J. S. Haldane, "that the problem of physiology is *not* to obtain piecemeal physico-chemical explanations of physiological processes, *but* to discover by observation and experiment the relatedness to one another of all details of structure and activity in each organism as expressions of its nature as an organism." The opposition stated is a false one, but by deleting *not* and putting *and* for *but* it can be turned into a perfectly correct statement Judging by his recent Gifford Lectures, Haldane might now be prepared to accept the emendation.

Human purpose is inseparable from design, an imagined goal towards which action is taken. Design gives the impression that the action is not causal, by the past giving rise to the present, but is the result of the future somehow affecting the present. This impression arises from the fact that the imagined goal is imagined as future. Whereas actually the process of imagining in the mind is present and may well be causal in the ordinary way. Prediction of human action from human purpose is simply prediction from causes of a special sort, namely imagined goals. It is precarious because they are only part causes and are liable to interference in unpredictable ways. Prediction from non-human purpose is more precarious still

because the imagined goal may be a mere figment.

In spite of appearances, when we acknowledge the existence of purpose there is no need to suppose anything so unorthodox as a pull from the future moulding the present. If there were, then the present could alter the past. It is true that one recent philosopher has urged this possibility with great ingenuity[1] The notion though attractive is difficult and highly paradoxical and I must be excused from pursuing what for the present point of view is a red herring.

Causal series have neither beginning nor ending, they just go on in some form or other. As soon as the notion of purpose is introduced then a set of events within certain causal series can be set apart as a unity with a beginning and an end, beginning when the purpose is first pursued, ending when it is attained or abandoned. This demarcation of units composed of means and ends is the characteristic alteration in our picture of the world that is brought about by teleology. Similarly the conception of organism gives a spatial demarcation. Without the boundaries set by the use of these two conceptions the causal world would be formless.

It is often assumed that the category of purpose is the ultimate one for the description of human action. That this is not the case will be discussed later in Chapter VIII, but there is no need to complicate the matter further at present. Human action whatever else it may be in addition, is at least purposive.

Adaptation

Human purposes are sometimes guided by an imagined goal but not always. It is most unlikely that

[1] G. H. Mead, 1932, *The Philosophy of the Present.*

the lower animals pursue consciously imagined purposes in this way. What happens is much better described in terms of *adaptation*. There are two sorts of adaptation: that whereby the organism is already *adapted* and that whereby it is *adaptable* to circumstances as they arise.[1]

The effect of surrounding processes on an organism is not the same as their effect on unorganized matter in the same circumstances. The flow of water in a stream carries grains of sand down with it, but it makes a fish turn his head upstream and swim against it. For the fish it is that special kind of cause called a *stimulus*.

In most cases the stimulus of flowing water finds the fish *adapted*, that is to say he gives the same response to the same stimulus and turns upstream. Obviously this cannot always happen or the head waters of streams would be crammed with fish and there would be none down below. The fish is *adaptable* and every now and then he fails to respond to that stimulus, responds to some other instead, and turns downstream.

The mere description of adapted response is perfectly easy, it consists simply in a certain specific response or set of responses to a specific stimulus or set of stimuli. It so happens that the response is such that normally it is well adapted to turn the situation to the animal's advantage. Thus if there is a tickle in your throat you cough and that is an adapted response, it will normally remove the source of the irritation. Every now and then of course it is not well adapted and you do your best to stop coughing. To give an explanation of adapted response is much more difficult and the current

[1] The conceptions of *normal* and *abnormal* or *pathological* are closely related and do not appear to need any separate discussion.

explanations are pretty lame and half-hearted affairs. In a simple case like a cough or a sneeze the matter is to some extent explained in terms of pre-existing bodily structure.

Matters are more difficult when one considers a really complicated case. A pair of birds will build an elaborate nest according to a definite pattern characteristic of their kind, though they have never seen a nest built before and could not profit by instruction if they had it. They are simply equipped by birth and inheritance with a capacity for carrying out a routine of actions when presented with a certain kind of situation —spring time, the presence of a mate, suitable sites and building materials. The routine of course is not absolutely rigid; within limits the birds' actions are adaptable to varying circumstances. In fact birds show more capacity to adapt their structures to varying sites and materials than ordinary human house builders; but that is by the way. The bird's capacity for nest building is generally said to be an *inherited instinct.* As Woodger has pointed out, this phrase is usually interpreted in a painfully literal and legalistic manner. It is assumed that just as you inherit your father's gold watch in virtue of the lawyer handing it over to you, the bird inherits its nest-building capacity in virtue of a piece of matter having been passed from the parents' bodies into the egg. The only difference is that the bird's piece of matter is assumed to have magical properties such as are not attributed to the gold watch. I am not here concerned to explain what is meant by inheritance or instinct, merely to point out that these terms as they stand are convenient cloaks for ignorance.

Adaptable behaviour at the level of conscious life is more easily dealt with, in terms of pleasure and pain. Successful action produces pleasure and tends to be persisted in and repeated; unsuccessful action produces displeasure or even pain, is not persisted in and tends not to be repeated. There is nothing against supposing that some analogous process of eliminating unsuccessful action and fixating successful action occurs among lower organisms to whom it would be rash to attribute conscious pleasure or displeasure. This account of adaptable behaviour includes the so-called "conditioned reflex" but is wider in its scope and can easily be enlarged to include rational behaviour. Adaptable behaviour means in physiological terms that any stimulus can and may produce any response.

We know from our own personal experience what we mean by adaptable behaviour and this gives us the impression that we understand the nature of the process. It may be urged that the impression is erroneous but at least it is there and the experience is there. Man is endowed with very little in the way of adapted behaviour apart from a number of quite simple and elementary reactions. He has to learn practically everything. The elaborate kind of adapted behaviour that is found among insects and some other animals is quite foreign to our own experience and for this reason seems mysterious.

There are analogies of adapted and adaptable behaviour in the sphere of structure which are worth considering for a moment. A specialized structure like a bird's wing or a horse's hoof is well adapted for its particular function but of course is no use at all for any other. The limbs of man are unspecialized and struc-

turally primitive. He cannot swim as well as a seal or run as fast as a horse or fly like a bird. But for the very reason that his limbs are unspecialized he can make and use tools and ultimately is able to surpass seal, horse and bird each in his own chosen element. Man's body is specialized in certain respects but it is in those respects that give him maximum plasticity of response and fineness of adjustment. They are the special development of eyes and brains, and the upright posture that frees his forelimbs from mere locomotion.

There is a price to be paid for all these things. The upright position is hard on the viscera which were designed to hang vertically from a horizontal backbone, and the sense of smell has been sacrificed to sight and the growth of the brain. It is pleasing to reflect however that even these handicaps are not without compensations. The subordination of the other senses to sight and specially the atrophy of smell is one reason at least why the intellect can sometimes triumph over the unruly instincts. Without the chronic dyspepsia which is the price of walking upright there would have been little literature and no philosophy.

As Professor L. Hogben (*The Nature of Living Matter*, 1930, Chapter IV) claims that Adaptation can and should be used in a non-teleological sense it is interesting to see how he defines it. He says (p. 105) " If we define adaptation as the *self-regulating* processes by which living matter retains its recognizable characteristics, it is a truism to say that *life is preserved* by adaptation." The words I have italicized are just as teleological and no clearer in meaning than adaptation. Further we are not told what are the " recognizable characteristics of living matter " nor how to tell a living thing from a lifeless one. One difference surely is that the lifeless thing does not do the purposeful sort of things that the living one does.

On p. 111 he says " Self-regulation, the way in which *an organism maintains* a seeming continuity of arrangement in spite of the uninterrupted and ubiquitous flux of macroscopic and microscopic changes which its existence implies. . . " Again I have italicized the key words Notice that " living matter " has disappeared and instead an *organism maintains its existence.* " Holism " which Professor Hogben so strongly objects to is let in almost openly and teleology is only thinly disguised If the language used means anything it means that the organism *tries* to maintain its existence.

Organism and Environment

Much biological discussion is based upon this distinction. Though valid and important for many purposes it rests upon an abstraction and there are limits to its usefulness, as J. S Haldane has pointed out. It rests ultimately upon considering the state of affairs at an instant, when there are two distinct volumes ; what is inside the skin is organism, what is outside is environment It is better to consider the organism as a focal region of ordered events surrounded by a region of relatively chaotic events. The organism's business is to produce what order it can after its own special pattern out of that chaos. But the surrounding chaos is not complete chaos, nor the internal order complete order. Moreover the material basis of the organism was once environment and will again be environment. From the side of the environment the organism is only an episode in its history ; while it lives it lives by exchange of matter with the environment and is closely limited by the nature of that environment. On the other hand from the point of view of the organism an important part of the environment consists of other organisms,

hostile, friendly, or serviceable, and contributing to the order or chaos special elements different from any that the inorganic supplies.

Consider the following two systems: (1) the sun shining on bare earth, (2) the sun shining on a plot of grass. The sun's rays can be treated as a simple isolated causal series. From the causal point of view the earth of (1) is a chaos. It is true that individual grains may have an ordered crystalline structure but this order is irrelevant for the present purpose. The earth is warmed up by the sun's rays so that the chaos operates at a higher heat potential but it is just as chaotic. The rise of temperature will be found empirically to vary in a regular way with the duration and intensity of the rays, but the law obtained from such observations has a statistical and not a strictly causal basis. That is to say the regularity will disappear on a microscopical examination as it rests upon a large aggregate of random processes.

Up to a point case (2) is similar. Part of the energy of the sun's rays simply goes to warm the ground, but there is a part that goes to maintaining the life and growth of the grass. The causal series that is a ray of light converges (along with others) on an ordered system that is adapted to receive it. It is a stimulus, that is a specific cause operating on specific ordered structures to produce an orderly response, but there is no simple quantitative relation between the energy supplied by the stimulus and the energy exchanges involved in the response. The laws that can be found to relate stimulus and response may be very complex but are probably causal in a stricter sense and not merely statistical; the regularity is not likely to vanish

on a microscopical examination as in the other case, but the macroscopical order is a reflection of microscopic order.[1] If there are apparent irregularities and lack of correlation between stimulus and response that is because the organism though orderly is variable and is a focus of convergence of other causal series besides the one in question. To insure an invariable response to a given stimulus all other variable factors must be held constant. Organisms however are not easily held constant. The point I wish to emphasize is that if an understanding of the organism is to be attained its relations must be considered in causal terms. If in practice regularities are hard to find and it is necessary to fall back upon statistical methods, as is often the case, it is definitely only a makeshift.

In the instance we are considering, a certain amount of sunshine will generally produce a certain amount of growth, given the constancy of other factors, such as moisture, temperature, soil condition and the whole past history of the plant including heredity. Usually moisture, temperature and so on are called environment and the past history of the plant called organism. That is looking at the plant from outside. From its point of view there is not so much difference, they are all convergent causal series. But the first lot are from the immediate past, are causally independent and not very orderly. The second set are from the remote past, are causally connected, and for the most part orderly.

In fact what distinguishes the organism is that during any period of time it is a region of orderly and

[1] By microscopic here is not meant sub-atomic but merely belonging to small aggregates of atoms We really need more words for different orders of small scale events

integrated events in the midst of a chaos. In saying the events are integrated I mean that their order is centralized and thus is entirely different from that of an ordered structure like a crystal which is merely endless repetition. There is of course repetition of spatial patterns but not mere repetition. Every leaf on an oak is recognizably an oak leaf and not a beech leaf, but the leaves are all different and the tree is not simply a pattern of leaves.

It is perfectly sensible to call the organism everything that is inside its " skin " at the moment and everything outside environment, provided the limitations of the view are not forgotten. The tree at any moment is what it appears to be, trunk, branches, leaves and roots and is not soil and air. But you cannot remove the soil and air and yet have a living tree for any length of time. The tree for the duration of its life is the " real " tree, the tree at any instant is only a cross section, a useful diagram.

In the preceding paragraphs I have deliberately chosen illustrations from plants rather than animals because the relation of a plant to its environment is more direct, simpler and closer than that of an animal. It is more nearly true that the organism is moulded by the environment. Environment will determine whether a tree is tall or spreading, big or stunted, crooked or well formed and so on. Yet in spite of all this its own characteristic forms and rhythms will appear. Provided it lives at all an acorn always produces an oak and a beech nut a beech. It imposes its own type of order on what would otherwise have a different order or none. From what impinges on it, it selects. What is selected depends upon the organism, with the obvious

limitation that it cannot select from what is not there. This selection is control, freedom, spontaneity or whatever you like to call it. It is seen in its rudimentary form in plants, in more advanced forms in animals and the higher the animal the greater the freedom.

Any one who is shocked at the introduction of such an improper topic as freedom may take comfort in the thought that life, as Sir James Jeans has said, is only a disease of matter in its old age. It is a passing ailment, occurring occasionally in most unusual circumstances. Sooner or later the physical universe will know it no more—after life's fitful fever it will sleep well.

The freedom of plants and the lower animals is limited by their dependence upon the vagaries of the environment. The higher animals have perfected a device for reducing this dependence, no less than the device of carrying their own private environment round with them. Most of the primitive animals are found in the sea and are essentially a bundle of cells floating in sea water. If the sea water changes in temperature or composition they must change too. If the changes are large or sudden the animal perishes. The sea, however, is big and in most places is not liable to great or rapid changes. Conditions on the surface of the earth are not so stable and not so suitable in other ways, therefore land animals consist essentially of a watertight skin inside which is a fluid, the blood, the state of which is kept constant by a number of elaborate mechanisms. The active cells of the body are bathed in blood, or more precisely in a fluid that exudes from the blood vessels, and are thus shielded from the slings and arrows of outrageous fortune. The higher up in the animal kingdom the more carefully is the shielding

done. It has been pointed out by Prof. J. Barcroft[1] that most parts of the body do not need all this cossetting but that it is done for the sake of one organ—the nervous system. If anything is done to alter the normally constant internal environment it is the nervous system that suffers first and most. Within the nervous system it is the highest centres that are most affected.

Man goes a step farther than other animals, and with clothes, houses, tools, machines and all the apparatus of social life and civil government, tries to control his external environment also. His efforts in this direction are astonishing; whether or not they are entirely successful I leave it to others to decide. Whatever differences of opinion there may be as to what has actually been done, most people will agree as to what ought to be aimed at. It is first of all to live and secondly to live well, in the sense in which the Greeks used that term—to be free to exercise the highest faculties and to rejoice in exercising them.

Man, like the toad ugly and venomous, bears yet a precious jewel in his head, and on this the exercise of his faculties depends, so that we must examine it. But first there are two minor red herrings to dispose of.

Equilibrium and Economy

As these two notions sometimes crop up in discussing living organisms it is necessary to be on guard against their very misleading implications.

An *isolated physical system* always tends towards *equilibrium*. The equilibrium state is one of minimum free energy so that work must be done on the system in

[1] *Features in the Architecture of Physiological Function.*

order to alter its state. It is also a state of maximum entropy; it is the most probable condition. Nothing in the world can be deader than a system in equilibrium.

Living organisms are never isolated systems, they are always receiving supplies of energy from outside, and they are never in a state of equilibrium as long as they are alive. What has deceived people is the fact that living organisms often aim (the teleology is deliberate) at maintaining a steady state in spite of external fluctuations. But this steady state is quite definitely not an equilibrium condition because its maintenance involves perpetual expenditure of energy; it is not a condition of minimum free energy or maximum entropy, far from it.

This is true as long as the organism lives. After death and in consequence of death a state of equilibrium may be attained but not always even then. If animal A eats animal B, B dies but equilibrium is not attained because it turns into A. If however B is caught by a zoologist and put into formalin in a bottle then a state of equilibrium is reached inside the bottle, which may for all practical purposes be treated as an isolated system.

The earth as a whole is not an isolated system because it receives energy from the sun. All life on the earth depends upon this disequilibrium at its surface. An organism can live only so long as it has some source of energy on tap to be used when and how it is needed and the ultimate source of all this energy is the radiant energy from the sun. Of course sooner or later this source of energy will fail and equilibrium will be safely reached at last, but long before that everything will be dead.

It is true that there is one special case in the working

of the living body where the notion of equilibrium is applicable and useful, and that is in connection with the functions of the blood, as any one will realize who reads L. J. Henderson's book called *Blood*. But the blood from this point of view is not itself living : it is merely part of a mechanism for maintaining a steady state. In the course of its work there are momentary attainments of equilibrium between the blood and its surroundings and a knowledge of the equilibrium states is necessary to an understanding of its functions. With this one exception it is safe to say that the notion of equilibrium is irrelevant to the study of organisms.

The notion of *economy* is not irrelevant but probably of minor importance. It is of course a teleological notion and is closely allied to the engineer's notion of efficiency, the ratio of the " useful work " that is done to the total energy put in to run the machine. It generally happens that the efficiency of a machine is greatest at a certain limited range of speeds. If it is run quicker or slower than this " economical " speed it is less efficient. There is a fair amount of evidence from the higher animals that their mechanical processes, such as running and the working of the heart, tend on the whole to operate round about the economical speed. But this is only a general tendency and there must be many exceptions. As A. V. Hill once remarked it is better for an animal to run fast and catch his dinner than to work with high thermo-dynamic efficiency and get no dinner. In general the thermo-dynamic efficiency of animal machines is about the same as that of good machines made by man, but there does not appear to be any fundamental significance to be attached to the fact.

Under certain conditions there is a tendency among living things to maintain the *status quo* and when disturbed to return to it. This has been called a tendency to economy, in a looser sense of the term economy. Thus animals asleep or resting tend to adopt posture and general bodily arrangements of minimum energy expenditure and after disturbance to return to them. This of course is not an invariable rule even under conditions of rest, and under other conditions does not hold at all. Most of the young of the higher animals " play " and this is a process of high expenditure of energy and the exact opposite of maintaining a *status quo*. Play is just as normal and important a function as rest.

As life is dependent upon maintaining a store of potential energy available for use and using it and also upon maintaining a " steady state " with regard to temperature, chemical composition and so on, anything that tends to disturb this steady state or reduce the store is resisted, but this is not economy or equilibrium nor is it describable at all in such simple general terms borrowed from physics or engineering. In fact if the general aim of living organisms is to be described in a phrase it is " life, liberty and the pursuit of happiness."

The matters dealt with in this chapter turn upon the question of what categories are to be used in discussion or description. Clearly we can discuss anything in terms of any categories and can make our account coherent as far as the information goes within those terms, but the account may be adequate or inadequate, important or trivial. A discussion of the tides or the weather in terms of purpose is clearly trivial. A discussion of the lower forms of life in terms of purpose is

not trivial but it is very difficult; for the discussion of human life it is obviously important. The category of organism is clearly more important for discussion at the level of living things but it is not trivial anywhere.

In conclusion there is no method of deciding *a priori* what categories are likely to be adequate and important for discussing what topics, we can only proceed by trial and error. The trouble has mostly been that people have been reluctant to profit by their errors. If discussion in terms of certain categories has resulted in the denial of plain fact they have denied the fact instead of revising their categories. For instance if discussion in terms of cause and effect leads to a denial of the possibility of freedom then surely it is necessary to revise or supplement these categories.

The division of objects into inanimate, animate, and personal is convenient as a first approximation but cannot be the last word. Categories hitherto applied solely to the animate may be applicable to the inanimate. Categories applicable to higher grades of the animate may be inapplicable to the lower grades. The lower grades of the personal do not differ much, if at all, from the higher grades of the animate.

J. S. Haldane[1] maintains, if I understand him rightly, that all categories apply at all levels and that the higher categories are more revealing and adequate not only at the higher levels but at all levels. This is a view I find difficult to grasp and am not prepared to follow, but it is not to be dismissed off hand as wrong or nonsensical.

[1] *Philosophy of a Biologist*, 1935, where his general attitude is summarized.

CHAPTER IV

THE NERVOUS SYSTEM

Cartesian Physiology

In this chapter an elementary account of the physiology of the nervous system will be given. Those who are acquainted with the subject will be bored and at the same time aggravated by the way difficult points are slurred over in the attempt to be simple and brief. Those who are not acquainted may find the account difficult to follow. I must apologize to both parties, and urge in defence that some account of this sort is necessary because psychology and physiology are haunted still by a theory of reflexes derived from Descartes. Originally it was a bold and fruitful hypothesis but its day is now done. In effect Descartes conceived the animal organism as a very complicated mechanical doll—you press the button and the figure moves. He was obliged to allow for mind, at least in man ; so the mind was a *homunculus* who sat in the brain and pulled the strings from inside. In the imagination of many he sits there to-day. Only Descartes put him in the Pineal Gland and now he is put into the Cerebral Hemispheres where at least he has more room to stretch his legs. It is time he was displaced and that we realized that the mind is not a *homunculus* inside the head but is *homo* himself.

The detailed discussion on the physiology of the nervous system, even though it contributes nothing positive, will be justified if it eliminates this fallacy.

Present day physiology deals with processes in visible

structures of the body and still makes use of the classical conceptions of physical theory. Its physical basis is not microscopic in the sense of theoretical physics. That is to say the smallest scale events with which it deals are transactions of large aggregates of the ultimate physical units. The single nerve fibre and single nervous impulse may be considered as physiological atoms, but they involve large numbers of physical atoms. In the following account the ordinary common-sense distinction of *structure* and *function* will be used. The distinction rests upon abstractions but it is convenient for exposition. The notion of structure arises by considering the organism at an instant, abstracted from time. The abstraction is valuable because within the history of the organism there are relatively stable events which do not change much and these are called *structure*. In contrast there are unstable events and these are *function*. In the end the distinction is quantitative and rests upon the time scale we are using. What remains stable throughout an hour may not remain stable for ten years.

(A bibliographical note is added at the end of the chapter in place of references in the text.)

Sense Organs and Muscles

The higher animals in their adult form are primarily sensori-neuro-muscular systems. That is to say they consist of the one hand of sense organs, or, more correctly and generally, *receptor organs* by means of which they are sensitive to processes in the environment and in their bodies. On the other hand they consist of muscles and other *effector organs* by means of which they can respond appropriately to these processes.

Mediating between receptors and effectors lies the *central nervous system.* The central nervous system is like the General and his Staff, the co-ordinating centre; but just as the General and Staff fight no battles themselves, the central nervous system is nothing without its receptors and effectors. All other organs in the body have functions that are subordinate and ancillary, they support, protect, supply with food and so on.

From the receptor organs a system of ingoing nerve fibres converge, carrying impulses towards the central nervous system and from it diverge a system of outgoing nerve fibres carrying impulses to the muscles and glands. Inside the central nervous system are sets of connecting nerves by means of which impulses may pass from ingoing to outgoing fibres. Some impulses may pass direct from the ingoing to the outgoing side; this is the simplest possible arrangement, but many of them pass through one or more intermediate sets of nerves. Impulses pass from one nerve in the central nervous system to another across a special structure (not yet clearly identifiable with structures to be seen under the microscope) called a Synapse. A synapse offers some resistance and causes some delay to the passage of an impulse across it, and it conducts in one direction only.

The outgoing nerves are of two sorts. First there are those going to the skeletal muscles, which move the limbs, trunk, neck, face and eyes, and are the muscles of common parlance. Secondly there are those belonging to the Autonomic System which go to the glands, the muscles of heart, blood vessels, viscera and a few other organs.

The Autonomic System need not delay us long. It consists of two sets of nerves Sympathetic and Para-

sympathetic ; where nerves of both sets run to an organ they generally act as antagonists. Thus impulses in parasympathetic nerves make the stomach secrete gastric juice and increase the activity of its muscular walls when you are hungry and eating. The sympathetic nerves stop the muscle working when you have a fright (hence that "sinking feeling"). On the heart muscle they have just the reverse effect, sympathetic accelerate, parasympathetic slow it down. Now heart and stomach muscle are spontaneously active and continue in action when all connections with the central nervous system are cut, consequently central control calls for two sets of nerves, one to increase, the other to diminish the spontaneous activity. The difference in the effects of the two sets of nerves is not in the kind of impulses passing along the fibre but in a different kind of process set up at the end of the nerve fibre where it connects with the muscle cells. The kind of inhibition produced in the heart or stomach is called *peripheral inhibition.*

The behaviour of skeletal muscle is quite different. Left to itself it does nothing at all. Accordingly it is supplied with only one kind of outgoing nerve, the motor nerve, the impulses in which throw it into activity. One single impulse in the nerve produces one single twitch of the muscle, that is to say a contraction or shortening immediately followed by relaxation or lengthening after which the muscle returns to the resting state. The muscle can be kept in a state of contraction for an appreciable time by sending a series of impulses down the motor nerve at such a rapid rate that there is no time for the muscle to relax after one before the next takes effect. This is called *tetanic*

contraction or *tetanus* and is a normal process not to be confused with the disease of the same name. All ordinary voluntary movements are *tetanic*, that is, are due to a series of volleys of impulses in the fibres of motor nerves, not a single volley.

When therefore a skeletal muscle is said to be *inhibited*, it is not the result of anything happening to the muscle. The inhibition is central not peripheral. What happens is that the passage of impulses down the motor nerve is blocked so that the muscle is simply not stimulated. Every impulse that passes down a motor nerve fibre is the result of an excitation process in the cell body of the nerve in the central nervous system. The excitation process is the result of impulses from other nerves reaching the synapses there. It may be opposed by an inhibitory process due to impulses from still other nerves. What happens in the motor nerve fibres is the algebraic sum of these excitatory and inhibitory processes.

Our knowledge of the excitatory and inhibitory processes in the motor nerve cells we owe to the work of Sherrington and his colleagues, and this will be considered further later on. In what follows the term *inhibition* will be used in a strictly Sherringtonian sense and must not be supposed to be necessarily the same as *peripheral inhibition*, though there probably are resemblances between the processes. Much less must it be supposed to carry with it the mythological accretions of popular pseudo-science.

The Central Nervous System

Every ingoing nerve to the central nervous system is connected with every outgoing nerve, some directly,

some less directly and very often by several different paths. Therefore stimulation of any ingoing nerve is capable of producing excitation, or inhibition, in any outgoing nerve. This is clearly seen at an embryonic stage in certain animals where any sensory stimulus produces a generalized muscular activity so that first all the muscles on one side of the body contract then all the muscles on the other side.[1] In most animals too at one stage of strychnine poisoning any sensory stimulus may give rise to unco-ordinated activity of large numbers of muscles. In fact co-ordinated muscular activity in response to stimulation is not necessarily due to forming new paths (though new ones may be formed) but rather to a canalization of connections between certain ingoing nerves and sets of related outgoing nerves, by inhibiting alternative pathways. If a specific motor response is regularly obtained after a specific stimulus, that is because all other responses are inhibited under those special conditions in which the specific response occurs; the organism is then *adapted* as far as that stimulus goes. In general however any other response may still be obtained under different conditions and so far the organism is *adaptable*. Co-ordination of responses means cutting out parts of a pre-existing but inarticulated whole and not the putting together of initially separated bits.

There really are such things as "conditioned reflexes," to use the fashionable jargon, but there is no such thing as an "unconditioned reflex"; it is a figment. All specific connections between ingoing and outgoing nerves that could be called reflexes are the result of

[1] See Coghill, G. E 1929, *Anatomy and the Problem of Behaviour*, also Holt, E B 1931, *Animal Drives and the Learning Process*.

some kind of " conditioning " by inhibition of alternative paths. What has been called an " unconditioned reflex " is merely a reflex response whose mode of conditioning is unknown or ignored, generally because it occurs at an early stage in the animal's life history.

While it is true that every ingoing nerve is connected with every outgoing nerve, it is also true that some connections are very roundabout and difficult of access, some are very direct and easy of access. Some indeed are the shortest possible ; that is, a branch of the ingoing nerve fibre makes a synapse directly with the cell body of an outgoing nerve. This is the nearest approach there is to the " reflex arc " of tradition, conceived as a definite restricted anatomical pathway. But even these most direct and most accessible connections are normally and habitually inhibited. The movements of walking require the alternate inhibition and de-inhibition or enhancement of sets of such direct pathways.

Before explaining this in detail it will be well to go back and consider the nature of the active processes in the simple units of which the pathways into and out of the central nervous system are built, that is the processes in nerve fibres and sense organs. To avoid complications I shall describe first a single sensory nerve cell supplying one (or more) of the stretch receptor organs in a muscle of arm or leg and then a single motor nerve cell supplying a group of muscle fibres in the same muscle. The reasons for this choice will be seen later and in any case these examples are sufficiently typical of ingoing and outgoing nerves in any part of the body to suffice for the present purpose.

The description may be taken as applying to man or any mammal.

The Nerve Fibre

A nerve cell consists of two parts, the cell body, which contains the nucleus ; and its outgrowths, the conducting fibres, one of which may be several feet long. The fibres have not only grown out of the cell body but they are all the time dependent upon it for their nutrition. If a nerve fibre is cut the part separated from the cell body can still respire and conduct impulses in a normal way for many hours, but in the end it dies. The other end can grow out to the organ that was supplied and renew the functional connection. The cell body of a *sensory nerve*, which may be 20 to 100 μ[1] in diameter, lies in a swelling (Dorsal Root Ganglion) on the nerve trunks, a pair of which spring from the dorsal side of the spinal cord, one pair to each segment of the spine. The process from the nerve cell splits in two ; one branch goes down the nerve trunk with thousands of other nerve fibres towards the receptor organ in the muscle (assuming for simplicity there is one only). When it reaches the end organ it splits up into a number of minute fibres round the *muscle spindle*, as the end organ is called. The other branch enters the spinal cord and there splits up again into several branches. One of these runs up towards the brain in the white matter of the cord, which forms the outer layer and consists entirely of similar fibres going up or down. Another may run downwards. Ultimately all branches enter into the grey matter, the innermost portion of the cord, either at the level of entry or higher up or lower

[1] μ = 0 001 millimetre.

down. Inside the grey matter are the cell bodies of other nerves and with some of them the entering fibres connect (synapse). The cell bodies of the sensory nerves are peculiar in that they lie outside the cord and that they have no synapses but are side tracked. The impulses appear to pass them by and they play no special part in conduction.

The long processes of the nerve both in the white matter and outside the cord possess sheaths of complex structure and rather mysterious functions. They are generally supposed to insulate the fibres from one another so that they do not interact. The nerve fibres possessing a sheath conduct faster than those (generally smaller) without one, but it is only the nerve process (axis cylinder) that does the conducting. Axis cylinders of different nerves vary much in size between 3 and 25 μ. in diameter. Where the fibres enter the grey matter they lose their sheaths ; in fact it is the sheaths that make the white matter white and their absence the grey matter grey.

The axis cylinder of a nerve fibre is a single conducting unit. It is true that minute constituent fibrils can be seen under the microscope with appropriate methods of preparation but there is no evidence that they are independent units or that under any normal conditions part of an axis cylinder can be active independently of another part.

The Receptor Organs

Our particular nerve is supposed to end in a stretch receptor or *muscle spindle.* This is an elongated structure not unlike an ordinary muscle fibre and

indeed probably in origin a modified muscle fibre. Many spindles are present in most muscles and even the smallest have one or two. The appropriate and specific stimulus is stretch or elongation of the muscle, which of course stretches the spindle too. Nothing is known about what happens in the spindle when it is excited apart from the effects produced in the nerve, but these provide two important pieces of information. (1) The process in the spindle is of variable magnitude; it is greater the greater the stretch. (2) The effect of a constant stretch dies away after a time. This dying away is not " fatigue " in any ordinary sense, because an additional stretch is just as effective as a stimulus as if there had been no previous stimulation. Likewise, a slow stretch is less effective than a quick stretch of the same amount. The dying away of the excitation with a constant stimulus is called *adaptation*[1] a term first used in connection with similar effects in vision, and now known to be characteristic of all excitable structures in the body. Speaking generally it is change of physical conditions which excites. Excitable organs differ qualitatively in respect of the specific physical change to which they are sensitive and also quantitatively in respect of their speed of adaptation. A nerve fibre, which is readily stimulated electrically, is generally only excited once when a current is switched on and immediately becomes adapted, so that as long as the current is flowing, i.e., a constant potential difference is maintained between the electrodes, nothing more happens. It is excited again when the current is switched off, i.e., when the potential difference drops

[1] Not to be confused with the non-technical meaning of adaptation used previously.

from its steady value to zero.[1] The muscle spindle is a relatively slowly adapted organ; the effect of a constant stretch gradually diminishes from the first but does not die away completely for many minutes. Other excitable structures are found to be intermediate between the very quickly adapted nerve fibre and the slowly adapted muscle spindle.

The Nervous Impulse

The next process to consider is what passes along the sensory nerve fibre as the result of stretching the spindle, the *nervous impulse* or *propagated disturbance* as it is called. The nervous impulse is difficult to investigate because the process is of very brief duration and the accompanying physical and chemical changes are minute. Recent developments in electrical technique have however made it possible and during the last ten years very important advances in knowledge have been made. These will be found described in the books by Adrian referred to at the end of the chapter. There is also an interesting account of the theory of the nervous impulse by Hill. The pioneer work of Keith Lucas is still worthy of study.

For simplicity let us first take the case of a nerve that is excited by passing through it an electric current of very brief duration, say the discharge of a condenser. In practice a nerve trunk containing many fibres will be used but only one fibre need be considered. If the electric potential is too small or the duration of discharge too brief nothing happens, but if potential and duration are above certain definite " threshold " values,

[1] When the current is switched on excitation occurs where it leaves the tissue (Kathode), when it is switched off where it entered (Anode)

the nerve is excited and an impulse passes along its whole length, spreading equally in both directions. Given one stimulus of moderate intensity only one impulse follows. The impulse is something very brief (about 1 msec. = 0·001 of a second) and while it lasts it occupies three to seven centimetres length of nerve. It is conducted at a speed of not more than 100 metres per second: much slower than sound in air, for instance. The nerve fibre like all other animal tissues as long as it lives is oxidizing organic substances (metabolism of rest) and thereby liberating energy for maintaining the living state. When it is thrown into activity the speed of these chemical reactions is increased (metabolism of activity). The metabolism of rest is perhaps needed to maintain some physical system at a high energy potential, like a fully charged electric accumulator. Even if no current is taken from an accumulator its charge runs down slowly so that some charging is needed to keep it up to its maximum. If current is taken from it the rate of charging must be increased to bring it back to the fully charged state. Similarly with the nerve fibre. While it is probable that the chemical changes follow after the passage of the impulse and are concerned with restoring the initial "charged" state, there is one measurable change that accompanies the impulse, that occurs when and where the impulse occurs and is an invariable accompaniment. This is an electrical change usually called the *action current* or *action potential*. The difference between the terms is purely a matter of technique depending upon whether current is measured in a low-resistance circuit or potential in a high-resistance one. The electrical change may be described with sufficient accuracy for

the present purpose by saying that when two electrodes are laid at different points on a living resting nerve no difference of potential is found between them. When an impulse passes under one electrode (A) that one becomes momentarily electro-negative to the other (B), as long as B is still in contact with resting tissue. When the impulse has passed by A and is still going on at B the state of affairs is reversed. This electric change has been known and studied for a long time and is not so very small when all the fibres in a nerve are excited simultaneously. It may then be more than ten millivolts and can be detected by quite simple methods, though it is not easy to record accurately because of the brevity and abruptness of the changes. But when only one or two active fibres are imbedded in a thousand inactive fibres or when the fibres are excited at different times the problem becomes difficult. Nevertheless records have now been made of the action potential in a single nerve fibre, with interesting results.

In the first place it must be made clear that *what* is transmitted from one end of a nerve fibre to the other is not matter or a specific form of energy, it is a change of state, an event. It has a wave-like character in that it rises to a maximum and then falls back to zero. If the action potential is a faithful index, the form of the wave can be determined. The most important point however is that it is an atomic event. Change in size of the impulses may be determined by change in size of action potentials or indirectly by the amount of heat liberated and they may change in size at any region on their path according to the condition of the nerve in that region. They do not change in size at all

according to the size of the stimulus. If the stimulus is too weak nothing passes down the nerve. If it is effective at all as much passes down the nerve as any stimulus however strong can produce What kind of signal arrives at the end of the fibre does not depend upon the length of the fibres and if a fibre splits each portion carries exactly the same signal as the undivided fibre. This is the *All-or-None Principle.*[1]

Please note that anybody who wishes to develop a theory of human freedom based on indeterminism has got a better basis in the All-or-None Principle in physiology whereby a small stimulus can do as much as a big one, than he has in the indeterminism of the electron. As I have no intention of developing such a theory, the suggestion is here given away gratis.

Closely connected with the All-or-None Principle is the phenomenon of the *refractory period.* That is to say when an impulse has passed, all that can happen for the time being has happened and an interval must elapse while things are built up again before a second impulse can pass. In the same way when you fire a rifle, the velocity of the bullet does not depend upon how hard you press the trigger. You either fire or you do not. Once the shot has been fired a second one cannot be fired until a fresh cartridge is pushed into the chamber.

Recovery after a stimulus is gradual so that there are two phases of the *refractory period.* In the first the *absolute refractory* period (lasting for 1 msec.) no stimulus however strong will produce any effect. In the second, the *relative refractory period* (lasting for 5

[1]The term *all-or-none* has been used in a very loose and misleading sense for processes of various sorts which are merely very coarsely graded or adjusted as opposed to finely graded or adjusted processes

msec.), a strong stimulus may be effective, but the impulse is smaller and conducted more slowly. After that the nerve is as it was at first (roughly speaking). To sum up, the normal and completely recovered nerve can carry only one kind of impulse and the impulse is an atomic event. It cannot carry a succession of impulses at more than a certain rate, about 1,000 per second, and if there are more than about 170 per second they are smaller than normal. The closer together they come the smaller they are and the stronger the stimulus needed to produce them.

So much for the effect of electric stimulation of a nerve; what is the effect of stimulation through the sense organ? If a muscle is stretched so as to excite a spindle the result is not a single impulse in the sensory nerve fibre but a series. For a stretch made suddenly and then kept constant, the series of impulses starts at a rapid rhythm which gradually slows down until at last the effect dies away. The greater the stretch the more rapid the initial rhythm of the impulses and, to some extent, the longer the duration of the discharge from the organ. In any sensory nerve fibre a more rapid rhythm of impulses is produced by a more intense stimulus of the receptor organ.

It is not easy even by strong stimulation of a receptor organ to produce a rhythm of impulses as rapid as 200 per second so that the impulses are not as a rule conducted in incompletely recovered nerve, but are usually of constant and maximum size in any one fibre.[1]

Each sensory organ, then, sends only one kind of signal along its nerve fibre but it always sends a number of them. So that it signals the intensity of stimulation

[1] The auditory nerve is very likely an exception to this rule

by the rate at which they follow one another. The impulses in fibres from different types of organ have different characteristic time relations and the organs themselves have different rates of adaptation. These differences may perhaps be correlated with the qualitative distinctions between different kinds of sensations. In any case the impulses from different organs travel in different paths in the central nervous system and this must account for the " local sign " that most of them carry. For instance a touch on the finger feels different from a touch on the elbow because, even if there are no other differences, the impulses follow different routes. The ingoing paths in the nervous system are to some extent " private paths," as Sherrington puts it ; they are used by one receptor organ or small group of adjacent receptor organs. This is in marked contrast to the outgoing side where the paths are all " common paths " available for impulses from many sources. What is known about the retina and recent observations on the ingoing tracts of the spinal cord show that this privacy on the ingoing side is partial and relative. The notion that there is always an exclusive independent route from sense organ to brain is false.

The recent discoveries just summarized as to the nature of sensory processes have solved many problems but have also raised certain difficulties. In particular it is not at all easy to see how the eye manages to signal colour differences, but since colour vision has always been a complete puzzle perhaps we are no worse off than before. There are certain difficulties too about hearing and pain. As regards pain there seem to be undoubtedly specific nerve fibres that conduct pain

only, but it is likely that excessive stimulation of some of the other fibres that normally do not subserve pain may produce pain sensations

It should be mentioned that each nerve fibre is inherently capable of conducting impulses either way, but when it is in the body it has no opportunity for doing so because it is connected with other structures which conduct in one direction only.

Motor Nerves

Turning now to the motor or outgoing nerves, there seems to be no fundamental difference between the impulses they carry and those carried by the sensory nerves. Consider a single nerve fibre running to a limb muscle The fibre originates in a cell lying in the ventral horn of the grey matter of the spinal cord. Towards this cell many fibres within the cord converge to form synapses, so that it is their *final common path.* From the cell body springs one long process running towards the muscle. Shortly before entering the muscle the fibre splits repeatedly so that ultimately it gives rise to a hundred or more fibres each of which supplies a single muscle fibre. The whole structure, cell and processes, is the *motoneurone.* The individual muscle fibres are capable of functioning independently but actually they are stimulated in bundles of 100 to 160, each bundle constituting a single *motor unit* of the muscle. The fibres of one bundle are distributed along the length of the muscle, so that contraction of a few motor units is effective in pulling the muscle attachments. It is seldom that a muscle is so short that a fibre extends the whole length and if fibres of each unit were all side by side the activity of a few units would

only slightly stretch the inactive fibres above and below and hardly pull on the tendon at all. A single muscle—that is the anatomically separate organ—is composed of tens, hundreds or of thousands of motor units according to its size.

During normal reflex or voluntary muscular activity series of impulses pass down the motor nerve with a frequency increasing as the muscular effort increases. The activity of the muscle is also graded by means of the number of motor units excited. The frequency of the impulses in an individual fibre is usually rather low, from five to fifty per second. At the slower rhythms, if the impulses to all active units were simultaneous the muscular response would be tremulous, because there would be time for partial relaxation of the muscle between each volley of impulses. Actually the impulses are *asynchronous*, specially so at the slower rhythms so that some muscle fibres are contracting while others are relaxing and a smooth movement is obtained At the higher rates of discharge there is a tendency for the impulses to different units to synchronize. The rhythm of the impulses in a motor nerve is set by the motor nerve cell or the higher centres connected with it. It is not a simple resultant of the rhythms of ingoing impulses.

By electrical stimulation of a nerve a series of impulses can be sent in at more than 200 per second so as to produce serious "overcrowding." Every impulse after the first is then travelling in incompletely recovered nerve and is reduced in size. It is possible in this way by strong rapid stimulation of a nerve to get only one twitch of the muscle with the first volley of full-sized impulses but afterwards no response to the smaller ones following. This is called *Wedensky in-*

hibition. The effect is due to there being some sort of block or resistance to the passage of an impulse between nerve and muscle which the smaller overcrowded impulses fail to get through. Since the synapses of the central nervous system are regions of block or resistance the suggestion has been made that central inhibition is of the character of Wedensky inhibition. The suggestion seemed plausible at one time and has received distinguished support, but it cannot now be upheld in face of the evidence obtained by Sherrington and his colleagues. It will suffice to mention two points. (1) A single ingoing nervous impulse (experimentally one volley of simultaneous impulses in a nerve trunk) is capable of producing central inhibition which lasts for an appreciable time. (2) The result of simultaneous excitation and inhibition is their algebraic sum; that is to say a small excitation is abolished by a small inhibition, a large one needs a large inhibition. Now a large excitation means a high frequency of impulses in the nervous paths concerned and should on the basis of the Wedensky effect be inhibited by a weaker inhibitory stimulus than a small excitation where the nervous impulses are less crowded. The suggestion may therefore be dismissed. Whatever the character of central inhibition may be there is no evidence that it is normally due to overcrowding of nervous impulses. That is not to say that inhibition of the Wedensky type *never* occurs but simply that it is not the ordinary normal type. It is quite possible that the general muscular inhibition or "collapse" sometimes produced by excessive emotional excitement may be a Wedensky effect, but this is a rare and probably pathological state.

So far I have described the effect of stretching a

muscle on its ingoing nerve and the effect of stimulating a motor nerve on its unit of muscle fibre. How are these connected? The answer is that the simplest possible connection exists, besides others more complex. One branch at least of the ingoing fibre from a spindle enters the grey matter at the same level of the cord and makes a synapse with one or more motoneurones supplying the same muscle where the spindle lies. This is the simplest and most direct kind of reflex arc and it is the basis of the *postural tone* of the muscles.

Reflex Activity of Muscles

All the skeletal muscles, but more particularly some of those in legs, trunk and neck, are constantly maintaining a slight tension, which tends to preserve the bodily posture. In standing, for instance, extensors, but also to some extent flexors of the legs are active so that the leg is held somewhat stiff offering resistance to any effort to bend it. The amount of tonic activity varies but it is never entirely absent except perhaps in deep sleep. Slight stretching of a muscle increases the tone for the time the stretch lasts and similarly slackening of the muscle diminishes it for the time, so that a limb in constant tone resists an effort to move it but if moved it tends to " stick " in the new position.

At any moment a few muscle spindles are excited and are sending impulses through to their associated motor units, keeping that group of fibres in a state of contraction. After a time these spindles become adapted, send out impulses at a slower rhythm and the motor unit begins to relax. That allows the muscle to stretch and excites fresh spindles that have hitherto been resting to stimulate their own group of fibres. And so on inde-

finitely. Each spindle and its motor unit is active in turn but not for long and each acts independently so that the impulses are not synchronous.

Active movement can be superimposed on the static condition of tone because the fibres from the spindles are not the only ones making synaptic junctions with the motoneurones. The motoneurones are the final common path of impulses from various sources, some excitatory, some inhibitory. If for example one leg is bent, as in the first movement of walking, excitatory impulses come down to the motoneurones of the *flexor* muscles concerned and increase any excitatory process already present due to impulses from the associated spindles. At the same time inhibitory impulses reach the motoneurones of the *extensors*, neutralizing the effect of impulses from the spindles and abolishing any pre-existing tone. When the leg is straightened again exactly the opposite happens. All movement may be considered as a modification of a pre-existing state of activity, which may have been static as far as external effects go. It always involves both excitation and inhibition, excitation of one set of muscles, inhibition of their antagonists. The inhibitory effect may be produced by direct connection of ingoing nerve fibres with motoneurones but more perhaps by way of one or more mediate neurones. It cannot be too much emphasized that inhibition is an essential part of all co-ordinated movement just as much as excitation is.

The Motoneurone

Sherrington and his colleagues have done much to elucidate the nature of the excitatory and inhibitory

state in a motoneurone. For a statement of the evidence their book must be consulted. Here it will be necessary merely to state the conclusions baldly.

The *central excitatory state* is not atomic as is the impulse conducted in a nerve fibre. It can vary in size like the excitatory state in a sensory end organ. The greater the excitatory state the greater the number of impulses sent out and the higher their frequency. It is perhaps legitimate to generalize and say that local processes are graded and it is only what is propagated from place to place by an explosive reaction that is all-or-none.

Every impulse that reaches the motoneurone along an excitatory path adds its quota to the excitatory state of the neurone. Whether all quotas are equal whatever path they come by one cannot say. The excitatory state is not stable but dies away spontaneously so that its magnitude is a function both of the number of impulses arriving and their frequency. It is probable that there is a maximum value for the excitatory state which cannot be exceeded however fast the impulses come crowding in.

The *central inhibitory state* is in most respects similar, but is the debit side of the account. The motoneurones apparently have no selective action at all. They merely add up the accounts. As long as there is a credit balance it is issued in the form of impulses in the motor nerve. If there is a debit balance there is no discharge of impulses in the motor nerve until it has been made up either by excitatory impulses to the motoneurone or by spontaneous decay. The " resistance " or " block " which may occur at a synapse is this debit balance. As the excitatory state decays spontaneously, even in the

absence of positive inhibition, a small number of excitatory impulses at a low frequency may fail to produce a credit balance. The ineffectiveness of weak ingoing stimuli does not always imply inhibition from other sources.

It is assumed that excitatory and inhibitory impulses arrive at the motoneurone by different paths and each kind always by the same paths. This cannot be demonstrated anatomically but it has to be assumed if it is true that nerve fibres carry only one kind of propagated disturbance, for it is only by a specific pathway that a specific effect can be produced.

This theory of Sherrington's has been called a "humoral" theory on the supposition that it implies the accumulation of two substances of opposed properties, but this is hardly fair to the theory or its author. It seems at least as probable that the excitatory and inhibitory states represent opposite processes, for instance the stabilizing or de-stabilizing of a membrane or the increasing or diminishing of an electric charge on some structure. It is true that there are peripheral excitatory and inhibitory states which are known to be "humoral," that is, are due to production of unstable chemical substances, but in combination their effect is not quite as simple as algebraic summation. The analogy may be misleading and ought not to be insisted on at the present stage of knowledge.

A Simple Reflex Movement

The simplest type of reflex movement is complex to this extent that it involves inhibition as well as excitation and involves several muscles. As Sherrington pointed out a long time ago, the number of muscles at

than others. (3) Although a given stimulus will under comparable conditions produce the same response, there is not one definite group of muscles only concerned. There is a group specially easily brought into action but many others may come in too. In any case the same motoneurones that give the response to this stimulus are also the *final common path* of other stimuli, a point to be discussed further.

Before passing on to the further question of the combination of reflexes there is another point to mention While it is true that in a spinal animal a given stimulus will produce a constant response it must be remembered that it will only do so under carefully controlled conditions. Actually with different internal conditions the same stimulus may produce different responses. The general state of the preparation as to oxygen supply, blood pressure and so on must not vary too much. In addition reflexes are very susceptible to fatigue so that stimuli must not be sent in too frequently. Most important of all when one speaks of *a* stimulus and *the same* stimulus one must be understood to refer to a localized action on a definite group of sense organs in the absence of any other stimulation or after-effects of stimulation of these or any other sense organs, or of any changing state of central excitation. The stimulus must be superimposed on a blank background or at least a uniform background. With a spinal animal of course the central nervous system is reduced to the cord, and sense organs practically to the skin and muscle-joint-tendon organs so that a blank background is more easily attained. In the intact animal it is not easy to apply " a stimulus " or " the same stimulus " because the background is seldom blank or

uniform and, even if it is, it is not easy to be sure of the fact.

Fusion of Reflexes

In the spinal dog another type of reflex movement of the leg can be obtained by stimulating the foot. If gentle pressure is applied to the pad of the foot the leg straightens out (extensor thrust). The movement is evidently a fragment of the walking mechanism; as soon as the foot touches the ground it straightens to take the weight of the body. Evidently the flexion reflex previously described and the extensor thrust command a similar set of motoneurones but in a precisely opposite way, where the one inhibits the other excites. What happens then when stimuli appropriate to both are sent in simultaneously, a prick and gentle pressure on the pad of the foot? If the motoneurones were the only cells concerned one would expect the results of the two stimuli to cancel out. Actually the result is never an algebraic summation of the two taken separately, but one reflex movement occurs or else the other. The movement that occurs may be smaller and slower as the result of its antagonist being stimulated but it is complete as far as it goes. Usually the flexion reflex is prepotent and the other is completely inhibited for the time being. Speaking generally the response to noxious stimuli prevails over the response to indifferent stimuli. What happens in the spinal animal is a fair representation of what happens in the intact animal. If the dog treads on a thorn while running he stops running with that leg and pulls it up out of the way. The three remaining legs suffice to carry on with.

At this point we may pause to notice that the terms "noxious" and "indifferent" or any reasonable alternatives are not only teleological but what is worse are "subjective" in the sense that only a sentient being who has experienced painful sensations can directly apprehend their meaning. But they could be explained in terms of purpose to a non-sentient but purposeful being. Otherwise they are unintelligible. Those who consider that scientific procedure should eschew the "subjective" and deal only with the "objective" will therefore feel suspicious and try to leave them out or explain them away. But these suspicions are due, I believe, to a simple confusion. All descriptive terms are ultimately "subjective" in the sense that they depend for their intelligibility on the actual qualities of sense experience. Could a being devoid of muscular sense understand the terms "force" or "inertia" as used in physics? Could one devoid of sight or muscular sense understand the term "motion" even? The distinction between subjective and objective has no valid reference to such terms. The distinction is significant, however, for certain relations between things and the methods of examining and investigating them. If I say Great St. Mary's is to the right of the Senate House in Cambridge I am speaking subjectively because the phrase "to the right of" has no meaning apart from my own special position in space. If I say Great St. Mary's is to the east of the Senate House I am speaking objectively, because my position is quite irrelevant, though when I discovered the fact I must have been somewhere in relation to them and where I was, was relevant to the way in which I made the discovery. My initial observation may very

well have been that Great St. Mary's appeared to the right of the Senate House and that I was facing north.[1] If I discovered it from the map the case is more complex though not essentially different, it involves the map maker and the map in addition to myself and the two objects concerned.

Perfectly objective investigations can and must make use of subjective facts and relations. But if these can be eliminated in the final account well and good. On the other hand some descriptive term appearing in the final account may be subjective in the sense of referring to a general quality or character of experience, which everybody or anybody may have. It is to be avoided only when it refers to something special, peculiar or private in experience, something that depends upon the circumstances of my body or your body and is not the same for any body.

There is a further difficulty that when speaking of a " painful " stimulus it is assumed that an animal experiences pain. I can see no fundamental objection to this assumption but if it is objectionable, as some consider, the primary difficulty can be overcome if the matter is considered causally. A noxious stimulus, like a prick or a burn, is produced by some process which if strong enough or lasting long enough will cause bodily injury, that is to say thwart the organism's efforts and lessen its chances of survival. The basis for the distinction between " noxious " and " indifferent " is teleological. The objections to teleology, as I have urged in Chapter III, do not appear to be serious provided the teleological account be considered as

[1]But if by " objective " we mean that any one in the same situation would make the same observation then it was " objective "

a statement of fact rather than as an explanation.

A noxious stimulus produces generally an avoidance reaction calculated to discontinue the stimulus, and generally the response to a noxious stimulus prevails over or inhibits an incompatible response to an indifferent stimulus. This I take to be a plain statement of fact. If an explanation is to be put forward it may be done simply, but of course "subjectively," by saying that a painful experience usually produces a stronger *motive* or *emotion* than an indifferent one, or more "objectively" but more speculatively by saying that a noxious stimulus commands more highly excited or excitable nerve centres However the matter is phrased some teleological term such as "injury" or "abnormal" must be introduced unless the plain facts are to be slurred over.

So far we have considered only the simplest kind of combination of reflexes, where the two are purely antagonistic and one is generally prepotent. There are many other reflex movements which can be obtained from the spinal animal and can be combined in various ways. They have been described by Sherrington in his *Integrative Action of the Nervous System* and no detailed account need be given here. It will suffice to state his general conclusion. When the stimuli giving two different reflex movements are combined, whatever the result may be, it is not the simple sum of the two responses obtained when the reflexes are elicited separately. That would constitute *confusion*, as Sherrington calls it, not *fusion*. The combination is always something functionally adequate. According to the nature of the case, the two stimuli may reinforce one another; a response to one may pass over smoothly

into a response to the other; one may suppress the other completely, itself appearing in a weakened form with some delay, or in full force. But something definite and of form that would be suitable to an animal's needs in an equivalent situation always appears. Whatever stimuli are coming in the response is a co-ordinated whole.

Reflex movements are not to be accounted for simply in terms of one set of synapses at the motoneurones. There must be other nerve cells and their synapses intervening between the ingoing and outgoing nerves. These intervening neurones must be responsible for the co-ordinating process, for all that is known about the motoneurones shows it is not they. The system consisting of a muscle spindle and its nerve with the associated motoneurone and its muscle fibres is in fact a machine or organ through which the co-ordinating centres can work; it is an instrument of (within limits) constant properties on which they can play. The movements that issue are merely the resultant of all excitatory and inhibitory impulses arriving at the motoneurone; its function, as has been said before, is simply to balance the debit and credit accounts.

The instrument it must be remembered, is not the motor nerve cell in the cord by itself, it is the whole system of muscle spindles, nerves and muscle fibres together which really constitute one complete motor unit. Possibly other receptor organs such as the tendon organs and their connections ought to be included and possibly also some intermediate neurones at the same level of the cord having inhibitory functions. But at any rate the system is not simpler than that of spindle, nerves and muscle fibres. Between the

constituents of the complete motor unit there is a sort of reverberatory relation. Impulses coming down motor nerve fibres alter the length and tension of the muscle fibres, that alters the state of excitation of the spindles, that alters the ingoing impulses reaching the motoneurones, that alters their excitatory state, that alters the impulses in the motor nerve fibres and so on for ever. The instrument is a peculiar instrument but still only an instrument. It is not a fixed or rigid piece of apparatus but a fluid dynamic system.

The interrelations between spinal reflexes must be further considered but first of all a rather puzzling though perhaps not very important question. If the stimulus for a reflex movement is repeated at more than a certain frequency its effectiveness gradually diminishes. This might be *adaptation* such as is found in sensory organs or it might be *fatigue*. Adaptation in sense organs is the result of coming into equilibrium at a new level with a new constant state. Repetitive stimuli if not too rapid for the organ to respond do not appear to produce adaptation. As all the stimuli within the central nervous system are repetitive, the result of repeated atomic nerve impulses, there is no good reason to suppose that any process analogous to adaptation occurs there. Obviously evidence is lacking but it is probably safer not to assume that the central process is one of adaptation. Fatigue is difficult to define and the term has been used extremely loosely, but it seems to mean essentially an impaired capacity to respond to a stimulus (which initially would have been adequate) in consequence of previous activity. For instance if current is taken from an electric accumulator at a slow rate the voltage remains constant for a long

time, the internal changes in the cells are able to keep pace with the current discharge. If, however, very large currents are taken the voltage drops and may quite quickly go down to zero, though it will rise again after a rest. This is analogous to fatigue. There is a maximum rate of steady energy output of any excitable structure. At a higher rate of output each response will be feebler than the last It will suffice for the present to call that fatigue without saying precisely what happens. Well, in this sense reflexes are readily fatigued but if a few minutes' time is allowed for recovery they can be elicited as before. Fatigue as seen in spinal reflexes is not to be attributed to the sense organs, nerve fibres or muscles concerned but to the synaptic junctions or the nerve cells. It represents the fact that there is a maximum rate at which impulses can be transmitted from a nerve fibre across a synaptic junction and received by a nerve cell.

As has been mentioned already the duration of the response is not limited by the duration of the stimulus but may continue for some seconds afterwards, the length of time depending on the strength of the stimulus; this is called *after discharge.*

Two further characteristics of spinal processes not yet mentioned are called by Sherrington *Immediate* and *Successive Induction.* To explain these it must be mentioned that there is a reciprocal relation between the two sides of the body. If you produce reflex flexion of the right hind leg you will get simultaneously extension of the left hind leg (Crossed Extension Reflex). The character of the normal process of walking or running makes the reason for this clear.

Now the response to any weak stimulus tends to be

reinforced or increased by the addition at the same time or a little later of another stimulus which by itself would have tended to produce a similar response. If the second stimulus occurs during the early stages of development of the response its reinforcing effect is most marked. In the later stages this, the *immediate induction*, is less marked and finally the opposite effect (*successive induction*) appears. For instance after a movement of flexion has been obtained there is a stage when the effect of any stimulus tending to produce extension is enhanced. Each single movement tends to pass over into its opposite. Add this effect to the reciprocal relations of the opposite sides of the animal and it is clear why it is found easy in a spinal animal to start the *stepping reflex*, in which the hind legs continue for a long time to execute stepping movements.

Bibliographical Note

Most of the information may be got from any up-to-date text book of Physiology by a judicious use of the index, but an unwary reader may find himself lost in a maze of irrelevant anatomical and experimental detail. The following monographs are probably the best sources of information. Sherrington's writings are very hard reading but the effort once made is well rewarded. The difficulties are not due to lack of precision in expression or clarity in thought.

Adrian, E. D., 1928. *The Basis of Sensation.*

Adrian, E. D., 1932. *The Mechanism of Nervous Action.*

Describe the fundamental work on the nature of the processes in sense organs and nerve fibres.

Hill, A. V., 1932. *Chemical Wave Transmission in Nerve.*

A discussion of the physical theory of the nervous impulse.

Keith Lucas, 1917. *The Conduction of the Nervous Impulse.*

Though now out of date is interesting as presenting the first clear understanding of the kind of process involved in nervous activity.

C. S. Sherrington, 1906. *The Integrative Action of the Nervous System.*

Still the classical work on Reflex Movement and contains many other points of interest.

Creed, Denny-Brown, Eccles, Liddell, and Sherrington, 1932, *Reflex Activity of the Spinal Cord.*

Describes the later work of Sherrington's School.

CHAPTER V

THE FUNCTIONS OF THE BRAIN

EXPERIMENTAL procedure in the physical sciences depends upon isolating a small number of variables, keeping everything else constant and studying how changes in one factor alter other factors. Wherever the number of known variables is large and wherever there are unknown variables or uncontrollable variables this classical method is relatively impotent. The data that can be obtained are uncertain or inexact, or, if certain and exact, tend to be trivial and miscellaneous, that is to say, they do not provide a basis for wide generalizations or for answering questions of interest. Physiology has for the most part used the classical method and in order to attain simplicity for experimental purposes, fragments of the organism have been studied in isolation from the rest. The parts may be isolated by the crude process of cutting them out or in more subtle ways. Thus the basic processes in the nervous system have been elucidated by studying what is happening in single nerve fibres while the activities of the others are eliminated. This in itself tells one nothing about how the nervous processes are co-ordinated. Sherrington's work does tell one something about this. He has dealt with large fragments within which there is a co-ordinating process at work but they are still fragments. At this level, that of the spinal reflexes, although uniform and predictable results can be obtained it is increasingly difficult to obtain them and above all increasingly difficult to devise experiments

and to interpret the results so that they do throw light on the internal co-ordinating process and do not merely give a mass of indigestible detail as to the relations between stimulus and response.

Still the spinal animal is such that it is possible to apply single simple stimuli of known character and obtain regular responses. With the intact higher organisms this last simplicity disappears. Similar stimuli may produce different responses, dissimilar stimuli the same response, for at any moment the organism is subject to innumerable shifting stimuli and fluctuating internal conditions. To take a crude illustration, if you are hungry the smell of toasted cheese is appetizing; if you are well fed it is indifferent or slightly unpleasant; if you are bilious it is nauseating.

The Conditioned Response

Many who have wished to investigate the working of the whole organism in men or animals, when faced with its complexities have in effect given up the problem in despair. They have assumed that the same single stimulus ought to be followed by the same response and have established special experimental conditions to obtain what they wanted. They have not noticed that in doing this they risk abolishing the organism as such. They have admitted one exception to the rule of invariable connection of stimulus and response; namely that a process of conditioning or learning may occur so that a stimulus by constantly accompanying another may come to be followed by the response due to this other.

I should have preferred to say little about what is mainly a blind alley, but the *conditioned reflex* has been

so widely advertised that something must be said.[1]

I shall consider mainly Pavlov's own work for he is at any rate a most skilful experimentalist, and he has been unfairly caricatured by over-zealous disciples. In the first place it must be acknowledged that Pavlov's method has brought to light many interesting facts about animals which could hardly have been got by any other technique and will continue to bring others to light. For instance, the evidence as to the dog's power of sensory discrimination, the action of drugs, the causation of sleep, and so on, is of great importance, specially when it can be compared with what is found in man by direct experience, or "subjectively." The criticism I have to make is that Pavlov's experiments tell us very little about the functioning of the whole animal or of the higher centres of the brain. His elaborate technique is in fact designed to eliminate the whole animal and the higher centres, since these would interfere with the success of the experiments.

There are two things to keep in mind. The normal dog, we must assume on the analogy of the normal man, is presented all the time with a diverse and varying sensory field, which in part is the result of his own bodily position and movements and varies as they vary. What occupies our conscious attention (or the dog's) at any moment is only a fragment of the total sensory field, most of which is vaguely apprehended "background," built up out of past experience as well as

[1] See W Kohler *Gestalt Psychology*, for criticism of Behaviourism. G. Humphrey *The Nature of Learning*, for criticism of the conditioned reflex. The references to Pavlov's work are to *Conditioned Reflexes* trans G. V Anrep, 1927 The use of the word *reflex* in this connection is objectionable on grounds of precision and the less definite term *response* is perhaps better A *response* may be a system or complex of *reflex* movements

contemporary experience. Any fresh single stimulus appears as an addition to the already existing background and is not unaffected by it. A light flashed on in a dark room is not the same stimulus as a flash of the same intensity for the same time in daylight, though the physical process is the same. This is an obvious case, but in no case is the stimulus independent of the background. Secondly, as Pavlov takes care to point out, a dog in any unusual situation or presented with some new stimulus has a characteristic response of "orientation" or "where is it?" He turns his head, pricks his ears, stands stiffly for a moment, and then perhaps sets off to investigate, or is alarmed, or loses interest, according to circumstances. This reaction Pavlov set out to eliminate because it interfered with the results he wanted. The dogs were put into a sort of sling which kept them steady in a room from which all stray sounds or lights or smells were excluded, and were put there repeatedly until the situation lost all interest for them. Then against this artificially blanked out background the special experimental stimuli were given. To put the matter in popular language the dog was not experimented on except when he had nothing to do and nothing to think about and was bored stiff. A model of experimental technique from the point of view of eliminating uncontrolled variables; unfortunately the dog was one of the variables eliminated. Had the experiments been done on dog-fish the claim to be studying the highest centres might be justified, but the dog is a more complex animal. As it was, Pavlov by this experimental procedure was studying a fragment of the animal, and not the whole animal, just as surely as if he had cut off

pieces with a knife. Unless you are dealing with the whole animal you are not likely to be dealing with the highest centres except in quite special and limited ways. A great deal of the discussion of animal experiments, particularly by the maze-running method, is open to the same objection.

I do not wish to be misunderstood. I am not saying that Pavlov's methods or the maze-running methods are useless and the results all wrong. I am only pointing out one of the *Idols of the Laboratory*. Where the experimenter attends only to the physical character of the selected stimuli he sends in and to the external response, and where the animal is constrained to produce the kind of response the experimenter wants and no other (or if he produces any other it is not recorded), then the results are of strictly limited significance and need cautious interpretation. They certainly form no basis for sweeping generalizations about the whole organism or the higher centres of the brain.

That the conditioned responses of animals do involve the activity of the cerebral hemisphere is clear. If they are removed entirely conditioning can be obtained with very great difficulty if at all. If parts are removed the rate at which new responses can be acquired depends upon the amount of cerebral matter that remains intact, as Lashley has shown.[1] But still it does not follow that the conditioned response tells us much or even anything about the functions of the cerebrum.

Consider what is meant by a conditioned response. The animal is presented with some stimulus or group of stimuli (Stimulus A) which is connected with a powerful

[1] K S Lashley. *Brain Mechanics and Intelligence*, 1930.

"motive" such as hunger or fear and to which a regular response can be obtained. For instance food is put into the animal's mouth to make it eat or salivate; or an electric shock is given at a certain place to make it go away. Simultaneously with Stimulus A or a little before it another is given, to which there is initially no definite response (Stimulus B). For instance, a light is turned on or a bell rung After a number of repetitions the animal will respond to B by itself as originally it responded to A. There are two things to notice. First, it is a necessary condition that A and B should stand out from a more or less indifferent sensory background (an extra outstanding stimulus, C, may interfere) and should not be too widely separated in time. Secondly, one of them must be connected with a strong motive, or, if you prefer, some strongly excited nerve centre. On these conditions depends their capacity to form a group, such that part of the group even if the rest is lacking will tend to produce the response that normally follows the whole. Given a powerful motive one occasion may be enough. Thus a child who has been sick immediately after eating an orange will find the smell of oranges nauseating for a long time afterwards, though probably the orange was quite innocent and he was really suffering from the effect of the previous meal. Or, if this example be thought too unpleasant, take the case of a child who has been frightened by meeting a dog in a certain lane and refuses to go down that lane again. Conditioned responses can easily be produced in man by using a painful stimulus for A. Observe that in the two examples of a child's behaviour what can act as B to take the place of A must be something which, though indifferent, still stands out from

the sensory background. The child's own clothes and the presence of mother or nurse are all part of the sensory field but are for this purpose mere background and not object and therefore do not get grouped with A. Observe also that this is not the kind of process likely to play much part in " learning " as usually understood among human beings or the old flogging methods would be the last word in scientific education. It is rather the material for irrational associations and superstitions. Animals are perhaps taught circus tricks by means of conditioned reflexes, but they are not the way to the higher flights of animal learning, such as herding sheep or retrieving game. For these a dog requires some degree of " insight " (to use Kohler's word) into the total situation ; something resembling a rational process which is not dependent on random association with crude strong motives like fear or hunger.

On the other hand the conditioned response may be the basis of symbolism by means of which the higher mental processes are carried out. It is certainly part, but probably only part, of what we call habit.

The Nervous Mechanism of Conditioning

The capacity to develop conditioned responses is found fairly low down in the animal kingdom ; not only throughout the vertebrate group but even among invertebrates with quite simple types of nervous system. If there is some doubt as to exactly how far down it goes, it is because of technical difficulties. Still there seems little doubt that some capacity for " conditioning " is found among Molluscs and Crustacea of the simpler sort and perhaps even among the more lowly Coelenterates, such as sea anemones.

Some complexity of nervous organization is necessary but not any special type of nervous structure. If the higher vertebrates cannot give a conditioned response without their cerebral hemispheres, it is not because that particular type of structure is essential but because in these animals they form the head ganglia. A Crustacean or Mollusc has no cerebrum but has a head ganglion. With it it is complete, without it incomplete. The main difference between lower and higher forms is the degree of dominance of the head ganglion and the complexity of the hierarchy of centres. In the lower forms relatively more functions can still be carried on normally without a head ganglion, but the total variety of different things that can be done even with a head ganglion is less.

The functions of a head ganglion, or of any higher ganglion relative to lower ones depend upon the fact that there are alternative paths between ingoing and outgoing nerves. Ingoing impulses arrive at different centres or ganglia at different levels and may be short circuited at a low level or long circuited at a high level. To take a simple case, if there is something irritating your throat, producing a " tickle " in it, then supposing your attention is not specially engaged, the ingoing impulses are normally short-circuited and produce a cough. Those that travel the long circuits may or may not make you aware of the tickle but nothing special comes of them; in any case the cough has already happened; as the small child said, " I don't cough, it coughs me." Suppose, however, something important is going on and it is advisable not to cough, then the short-circuit is inhibited by impulses from the higher centres and anything coming in has to be long

circuited to produce a response at all. The response may consist in violent struggles to suppress a cough. It has been said, though it is rather an exaggeration, that the main function of the higher centres is to inhibit the lower. But at any rate as long as the higher centres are active if a short circuit is open it is because they leave it open, if it is closed it is because they close it.

Every ingoing impulse may be long-circuited and if so it may be inhibited on the long circuits and so produce no response. In this case it is "indifferent." On the other hand through the long circuits it can have access to any or all outgoing paths and hence the possibility of conditioned responses. By the short-circuit it has access only to a limited group of outgoing paths to produce a fairly specific response, as the study of spinal reflexes shows. The "indifferent" stimulus needed for a conditioned reflex is neither simple nor primitive, but is generally a complex result of some kind of "conditioning" process.

According to this argument, for a conditioned response to be possible there must be alternative paths and long and short circuits, but it does not follow that any conditioned response necessarily uses the longest paths of all through the highest centres.

It may be objected that there is a kind of "conditioning" process known whereby a stimulus may become indifferent, and that it is found among very lowly organisms as well as more complex ones. An experiment described by Humphrey[1] illustrates the kind of phenomenon in question. A snail is allowed to crawl over a board which can be given a slight jerk at

[1] G. Humphrey, 1933, *The Nature of Learning*. Chapter VI.

intervals of two seconds. At first each jerk makes it draw in its horns, but after several repetitions produces no effect. *Habituation* as he calls the process, is shown by practically every type of animal and is of course a familiar phenomenon. Noises that at first make you start or attract your attention cease to have any effect after several repetitions. There is also a process of *Dehabituation*, a stimulus that has ceased to produce a response may produce one again on an occasion when it is accompanied by some other extraneous stimulus. In general the kind of stimuli to which the organism becomes habituated are not those connected with any definite motive or strong excitation, but typically are slightly disturbing or mildly unpleasant such as produce a feeble response of the avoidance type. From the point of view of direct experience the process is the fading of a slightly disturbing sensation into the background of the sensory field.

Whatever the nature of the process of *Habituation* may be it probably does not need alternative paths and Pavlov's conditioned reflex does, because the B stimulus may be conditioned to more than one kind of A stimulus. So that it is only in a very loose sense that habituation is a kind of conditioning.

I have tacitly assumed, and for this there is direct evidence to be considered later, that whether or not ingoing impulses pass through to the outgoing side depends upon the state of excitation already existing in the nerve cells they run to. If a nerve centre is only feebly excited at the best of times it is not hard to understand that after it has been discharged, subsequent sets of impulses find it still less excited and less easily brought to the point of discharging. Dehabituation

then would simply be the increased state of excitation due to impulses from an extraneous source entering the same centre. In any case this phenomenon does not seem to need more than the simplest nervous machinery, one path and one ganglion, and there does not seem to be any resemblance to the conditioning process of Pavlov's type. Habituation is probably a "fatigue" effect, using fatigue in the most general sense of a process diminishing or ceasing altogether because something has been exhausted by previous activity faster than it could be supplied (or accumulated faster than it could be removed).

There is another objection that might be raised. It is not absolutely essential that the B stimulus be strictly indifferent. Pavlov has found that an electric shock or other slightly painful stimuli (but not violently painful ones) can be conditioned to produce salivation or a feeding response. These would otherwise produce a fairly definite response of avoidance, but can be inhibited on their short circuit without great difficulty. This will happen when there is a strong excitation such as that connected with feeding and they are then equivalent to indifferent stimuli, that is to say they have no outlet except by the long circuits.

It cannot be too strongly insisted that an indifferent stimulus is not something simple and elementary but something complex and derivative. The simple primitive state of affairs is for a stimulus to be strong enough to produce a response, or else too weak to do so, so that it is just nothing. The indifferent stimulus is something that is temporarily producing no effect owing to inhibition but yet is capable, given suitable internal conditions, of producing an effect. It involves,

that is to say, alternative paths and varying states of central excitation and inhibition.

The matter may be made clearer by considering the case of a lowly organized animal. Between a highly and a lowly organized animal there is a difference in complexity of structure and a corresponding difference of behaviour. The lowly organized one has few receptors, few effectors, and few intermediate nerve cells. The hierarchy of centres is not well marked: they may be all free and equal. The animal is sensitive to no great variety of stimuli and can only perform a few different kinds of acts. In some ways the complete lower animal is like the spinal higher animal and particularly in this that a specific stimulus generally produces a specific response, if it is effective at all.

The most rudimentary kind of nervous system, the nerve net, merely allows a state of excitation to spread to effectors at a distance from the seat of origin of the stimulus. Such a structure could hardly produce a conditioned response. We must consider then an animal with a rather more complex organization than a simple nerve net.

The oyster for example is sensitive to chemical substances and suspended matter in the water entering between its valves and is sensitive to little else. It can respond by closing its valves, or opening them, or by alternately opening and closing. This last manœuvre is not vacillation of will, but is a functional process necessary for its mode of feeding by sieving off the fine suspended matter to swallow it and by rejecting the coarser particles. The movements vary in amplitude and frequency according to the amount of suspended matter. The response to a noxious stimulus

is to close the valves and keep them closed. This may happen in spite of the normal "feeding" stimulus so that even the oyster faces and solves the fundamental problem of behaviour, of choosing between alternatives. This is the kind of process that may be the work of a head ganglion, but then if there is one ganglion only it must be the head.

The oyster has more than one ganglion altogether but each probably acts more or less independently of the others. There may be no alternative routes available, but from any receptor only one circuit through one ganglion. With such an arrangement ingoing impulses will either produce a specific response or else nothing at all because they are inhibited by some other contemporary process in the ganglion. I doubt whether anybody has ever tried to get a conditioned response out of an oyster. If he succeeded it would indicate that it has a more complex organization than I have supposed. In any case the example of the oyster is introduced simply to show that there is reason to expect a definite lower limit of complexity below which a conditioned response could not be obtained, and this turns upon the existence of the alternative paths that are necessary for an indifferent stimulus.

Nervous Paths

Before going on to see whether anything can be said about the higher centres, it is necessary to consider the anatomical evidence, which, as far as it goes, is of great value. If a nerve fibre is cut the part that is separated from the cell body degenerates, and degenerated fibres are easily distinguished microscopically from normal

ones. Synapses are generally at the cell body, so that the impulses in the main nerve process run from the cell body, therefore the direction of flow of the impulses can be discovered by the degeneration method. Large numbers of tracts in the white matter of brain and spinal cord have been mapped out in this way. Thus it is known that ingoing impulses travel up along certain tracts of the cord but not higher than *thalamic* centres at the base of the fore brain where they have synapses, from which other fibres run to the cerebral hemispheres. But it is not possible to tell exactly what other lower synapses are made by the first ingoing fibres though some such evidently exist or there would be no spinal reflexes. This is because, where there is a tract of fibres running up, there is nothing to indicate if the fibres divide and send branches into the grey matter.

On the outgoing side, most, perhaps if we exclude the autonomic fibres, all motor nerves start from the cells of the ventral horns of the grey matter in the cord and the corresponding cells in the brain supplying muscles of the eyes and face. Many fibres make synapses at these motoneurones, but specially important are the *pyramidal fibres* which come direct from certain large cells in the cerebral cortex. Within the white matter of the brain itself many connecting tracts have been made out linking up various nerve centres, some of them crossing from one side to the other. Within the grey matter there are probably no distinct paths completely insulated from one another.

There are two questions that ought to be answered and are not yet answerable. These are (1) how many fibres make synapses with any group of nerve cells and from where do they come; (2) what alternative

routes are available to impulses in any particular tract of fibres? The diagrams drawn in the books are partly guess work, are always over simplified, and cannot be considered as answers to these questions.

In fact when one speaks of paths in the central nervous system it is very easy to slip into serious errors; more particularly of thinking of definite unique routes between ingoing and outgoing nerves and of thinking of the central nervous system itself as a passive pathway. The rhythm of impulses in an outgoing nerve is set by the motoneurone itself and its inherent properties. The rhythm is influenced but not uniquely determined by the rhythm of any one set of ingoing impulses. Each cell or group of cells is at any moment in a characteristic state of excitation, or inhibition, which it may possess independently of any nervous impulses reaching it at all. Normally many impulses are reaching it simultaneously from many sources and all contribute to increase or diminish the state of excitation. What issues from the cell as impulses in its *axon* or long process is a resultant of its inherent activity and of all impulses arriving at the time and for some time previously (how long it is hard to say).

In the paths of the white matter each fibre is insulated from its neighbours so that nothing they do makes any difference to it. In the grey matter where the cell bodies and synapses are there is probably no complete insulation. There is almost certainly spread of activity from one cell to its neighbours. Though the spread is not confined to definite paths it probably follows some orderly arrangement. The evidence comes from several sources. In the first place the absence of the insulating sheaths suggests that the signals carried

cannot be quite private. Then there is the fact that in spinal reflexes the number of motoneurones excited increases with the strength of the stimulus in the ingoing nerve and the further fact, found by Adrian and Sherrington, that with low intensity of stimulation impulses in motor nerve trunks are asynchronous while with high intensity they tend to be synchronous. Lastly Adrian has been able to show that there is a distinct tendency for the cells of the cortical regions to show rhythmic activity and where there are no strong ingoing stimuli the rhythms of neighbouring groups may be similar and in phase with one another. Ingoing stimuli tend to break up the rhythmic pattern. This is true for the cortex of anæsthetized animals and also for the human cortex during conscious activity.

The Excitatory State

It was suggested above that some nerve cells have an inherent activity independent of nervous impulses reaching them from elsewhere. This is obviously not true of motoneurones, who speak only when spoken to, like the model Victorian child. But it is strikingly true of the cells of certain of the " automatic " centres of the brain. The best known case is that of the Respiratory Centre. At each inspiratory movement the motoneurones supplying the diaphragm and some of the chest muscles send out a train of impulses, then there is a pause for expiration. The trains of impulses follow in succession to keep up the normal rhythm of breathing. These impulses in the motoneurones are the result of a rhythmic activity of the cells of the respiratory centre in the hind brain from which fibres pass to the motoneurones concerned. Now there are

ingoing nerves which carry impulses to the respiratory centre and have an effect on it so as to alter the rhythm. Some of these are coming in regularly, such as those from the lungs produced by their inflation and deflation. Some only come in occasionally such as those that come from the skin, when you jump into cold water and give a gasp. But it has been shown that even when all ingoing nervous impulses are abolished and even when the connections with the muscles are cut off rhythmic activity of the centre still goes on. Recently Adrian has found that the very simple respiratory centre of the water-beetle still continues its rhythmic activity when completely removed from the body. This means that a state of excitation arises periodically in the cells and then discharges itself, and the excitation does not depend for its existence upon nervous impulses from elsewhere but is entirely home grown. Although home grown it is not altogether independent of external conditions. As Haldane first showed, it depends upon the composition of the blood circulating through the nearest blood vessels. The more *carbon dioxide* there is in the blood the more excited are the cells of the respiratory centre. If there is less than a certain pressure of carbon dioxide the excitatory state disappears or at least becomes too feeble to produce respiratory movements. Anybody can try this for themselves by breathing very hard so as to wash the carbon dioxide out of the lungs and therefore out of the blood. After a bit they will find they cannot breathe at all and will remain without breathing for as long as a minute or two until enough carbon dioxide has accumulated in the blood to stimulate the respiratory centre once more.

This effect of carbon dioxide on the respiratory centre is specific. Most cells of the brain are not affected in the same way; but there are other cells of other automatic centres which are specifically affected by other changes in the blood. Temperature changes affect the cells of the heat regulating centre.

To say that nerve cells have an inherent activity does not mean that they are independent of external conditions but that they are not like motoneurones which simply balance up from moment to moment all the excitatory and inhibitory nervous impulses arriving there. The external factors, other than nervous impulses, which do and do not affect the inherent activity of the respiratory centre are known. The factors that affect the cerebral cells are unknown but we are entitled to guess that the cells have an inherent activity over and above the resultant of the excitatory and inhibitory nervous impulses that reach them. The central nervous system is not simply a set of pipes by which the sense organs are connected with the muscles (the Cartesian Theory) but its cells have their own native activities which are modified by the impulses arriving from outside.

Persistence of Effects

Experiments on the spinal cord show that the after effects of any stimulation are a matter of seconds or a few minutes at the most. At the end of that time the system under normal conditions settles down to a fairly steady state. But one knows that in the higher centres or the whole animal the after effects of stimuli may last for hours or for years. What is the reason for the difference?

The advantages of there being such a difference are obvious. The spinal cord is an instrument and its business is to carry out orders. The orders may not be specific but general so that it is left to the spinal centres to co-ordinate the process. Thus a dog's higher centres may give a signal which means simply "Run"; the brain stem and cord centres have then to work out the detailed instructions needed to set the legs in motion in the right order and keep the body balanced. There is, therefore some room for autonomous activity, but it is essential that once the orders have been carried out the lower centres should settle down as soon as possible to a stable state in which fresh orders can be executed in a predictable manner.

In passing from the short period changes that have been investigated in the spinal cord to the long period processes of the higher centres which must exist but have not been investigated by physiological methods it is possible that we are passing to something qualitatively different. If that is so, there is little hope of anybody now living ever knowing much about the physiology of the higher centres. On the other hand it is possible that the change in time scale is a quantitative and not a qualitative one. There are after effects of activity that persist for a minute or two in the lower centres and they may throw some light on those that persist for years in the higher. It may be some small comfort to reflect that the slowest muscles take about 10,000 times as long to contract as the quickest and yet there is good reason to suppose they all employ similar machinery.

Matters of habit, persistence of mere routine patterns of movement may be explained with fair accuracy in

terms of paths ; once impulses have passed through by a certain route it is easier for others to do so in future. Should a definite restricted path be open to a group of impulses it is open only if (*a*) the nerve centres on the path are excited or excitable, (*b*) the path is nowhere blocked by inhibitory impulses from other sources, (*c*) alternative paths are not open. This is rather an important " if." Strictly speaking there are no paths in the grey matter only in the white matter. Moreover habit is not necessarily the business of the higher centres at all.

It is customary in speaking of these matters to refer to " traces " in the nervous system, particularly when speaking of memory images which probably do concern the higher centres. But if " traces " is used in the sense in which one speaks of " traces " of yesterday's breakfast surviving on to-day's table-cloth, the notion is fallacious. What survives cannot be a material object like a spot of marmalade any more than it can be merely a path ; it must be a state of organization making it easier to repeat a process.

Perhaps the nearest to an analogy can be got from the phenomena of sound. Imagine what would happen if there were such a thing as a plastic resonator. Originally it has no natural period, but once it has been set vibrating to a particular note played very loudly, it will again vibrate to that note at any future time even if it is played very softly. To any other note it will not resonate so readily, though it might be distorted to resonate to it if its pitch were not too far from that of the original note or if it were loud enough. Admittedly the analogy is not perfect and nobody has ever seen a plastic resonator, but I am sure that resonance provides a much closer and more illuminating analogy than

" paths " and " traces." What is more " paths " and " traces " are liable to be taken literally and therefore are more likely to be definitely misleading.

I shall assume that the cells of the higher centres develop some state of excitation of their own independent of ingoing impulses; that is they are more like the cells of the respiratory centre than the motoneurones In fact the respiratory centre has the properties of a head ganglion except that its function is simple and constant under all ordinary conditions. The functions of the cells of the higher centres are neither simple nor constant, it is part of their function that when they have been excited in certain ways their own inherent mode of excitation is modified permanently or temporarily. The modification it must be remembered may be in either direction, so as to make a performance more easily repeated or less easily repeated. I am assuming also that any ingoing group of impulses has access by the long circuits to many centres. On most centres it will have no effect but some may be set resonating because of some similarity between the present group and some group in the past. Thus if I look at a round object, say the full moon, different fibres of the optic nerve are differently excited from moment to moment (as I move my eyes about); but as among the whole lot of them a certain constancy of relations is maintained by which circularity is recognized, so the object does not appear to alter although I move my eyes. That might be because such a spatial distribution of impulses, by whatever particular fibres they travel, sets some group of cells resonating. If I hold a penny in my hand I recognize a similarity with the sight of the moon in respect of roundness though

the paths of the ingoing impulses are entirely different. I can even get the same recognition of roundness from a temporal pattern by running my finger round the rim of a tumbler—but this is getting too complicated and must be left undiscussed for the present. In any case the whole subject is highly speculative.

Two warnings must be uttered *a propos* of what has been said. While it is necessary to emphasize *plasticity* of response whereby the organism's response is altered by previous activity; it must never be forgotten that the organism's *elasticity* whereby it is not altered is equally important and characteristic. Forgetting is at least as important in mental life as remembering, perhaps more important because we forget more than we remember. We are capable of selecting what is to be remembered and what forgotten.

The other warning is that in speaking of the excitatory state of nerve cells one need not assume any specific type of "nervous energy" or anything mysterious. Nothing definite can be said about the excitatory state except that it is that condition which leads to impulses passing down the long process. But it is highly probable that it is fundamentally similar in all excitable cells inside or outside the nervous system. The state of excitation probably involves an increased energy output, but in the case of nerve cells this increased energy output is quantitatively inconsiderable. As far as energy goes the output of the brain of a Newton or a Shakespeare would hardly differ by twenty per cent. from that of the Village Idiot. I doubt whether the activity of anybody's brain cells needs more energy than would be supplied by one small ham sandwich *per diem*.

Control of the Higher Centres

Leaving out of account the essentially subordinate activities of the Autonomic System, all central activity finally emerges as impulses running to the motor neurones. These are both inhibitory and excitatory under all conditions. But if there is an overt movement we call it *action* and if there is none we call it *inhibition* in the popular but not the physiological sense of the word. This is an artificial use of the word because to refrain from action is physiologically an act just as much as acting since the muscles are doing something all the time. But there is a ground for the popular use of the word in that what is called inhibition generally has no direct or definite social consequence, what is called action has. This is not always so, of course ; if I see a man being attacked by a hooligan and I refrain from coming to his aid that is an act with social consequences just as much as if I do come to his aid. But for the present purpose it is convenient and simplifies matters to call an act some overt movement which produces some directly noticeable effects, because that is the ordinary and usual form an act takes, while refraining from action very often has no direct consequences and is in any case not easy to observe from outside.

Assuming then that the end result of any central process is an overt act, this may happen in various ways according to the extent to which the organization is centralized. Among the lower organisms there is little centralization. Local ganglia subserve local functions and the head ganglia have only a general excitatory or inhibitory effect. The organization resembles the con-

stitution of Switzerland rather than the French Republic. In a lobster, for instance, the head ganglia are bigger than the others because they receive nerves from the eyes, antennae, and other organs of the head, but they are not enormously bigger. Probably they merely issue general instructions, as it were, "forward," "stop," "reverse"—and leave it to the local ganglia to work out the details. In any case the motor acts are only coarsely graded and adjusted and are capable of little variety.

Among the higher vertebrates there has developed an entirely new type of head ganglion. In man it reaches such absurd proportions, that a visitor from another planet would almost certainly consider it pathological. However that may be, here we are saddled with a huge ganglion or pair of ganglia called the *cerebral hemispheres*. These structures dominate the body to an extent unknown elsewhere in the animal kingdom. They are not content with exercising a general control over the skeletal muscles such as they exert over the visceral processes through the autonomic system. Impulses from the *cerebral hemispheres* travelling a rather indirect path through several synapses may make your heart beat faster or slower but the exact manner of the beat depends upon the heart itself. Similarly impulses from the *cerebral hemispheres* may make your face blush or blanch; no power on earth will make one side of it blush while the other blanches. Yet it is easy enough, with a little practice, to wink one eye and not the other or to smile on one side of the face and not the other, like Mona Lisa. The control of the cerebral hemispheres over skeletal muscle is direct and finely graded. In the spinal cord this is seen anatomically

in the development of the *pyramidal tract* of fibres, only found in mammals and most highly developed in man. Through this tract cells in the cerebral cortex are in direct connection with the motoneurones throughout the body. Voluntary muscular movement is almost certainly mediated by the pyramidal fibres but it is a mistake to suppose that in such movement no other fibres are involved. Voluntary movement is highly co-ordinated and other centres and their fibres in the brain (specially the *cerebellum*) and in the cord are needed to do the co-ordinating. But the pyramidal fibres represent the primary and most direct connection between the highest centres and the muscles. Voluntary inhibition of movement must be brought about in the same way, *mutatis mutandis*.

In the lower mammals where there are fewer pyramidal fibres the lower brain and spinal centres are more independent of the cerebrum and more capable of bringing about co-ordinated movement than in man, where the spinal centres are so completely dominated from above that by themselves they seem to be quite impotent. As we ascend the animal scale there is an ascent in complexity and centralization not only on the sensory side, as everybody knows, but also on the muscular side. That is to say muscular movement becomes a more and more intellectual business. Animals move with great rapidity and violence and therefore with great effectiveness up to a point. But the variety of movement is limited and the co-ordination and adjustment is coarse. No animal, not even an ape, is capable of the feats of co-ordination and adjustment of movement displayed by a skilled skater or acrobat. I quote these types of muscular activity

because they involve the whole body and the body only and are not concerned with man's peculiar tool-using proclivities. They are in fact the kind of feat an animal could perform if he had the *brains*.

Thought and Muscular Action

At the suggestion that muscular movement may be intellectual I feel that there will be a stirring of indignation among the highbrows. They will say, " Why all this talk about acrobats and muscular activity? Granted that what the acrobat does is perfect of its kind it is not properly an intellectual activity, like the mathematician's for instance." In reply to this I should admit at once that what the mathematician does is much more useful than what the acrobat does; but is there any reason apart from snobbery for saying it is more intellectual? In effect the acrobat *thinks* with the muscles of his whole body while the mathematician *thinks* with—well, whatever it is he thinks with. Of course it may be that the mathematician does not think *with* anything but just thinks. Even if this were true, which is doubtful, I find it hard to see why thinking with nothing should be more truly thinking than thinking with your muscles. Because thinking is mental it does not follow that it is not bodily too.

A Behaviourist, if he were present, would step in at this juncture and say that all thinking whatever is done with the muscles, in fact simply is muscular movement, which may be quite openly visible as with the acrobat or concealed as with the mathematician. He would go on to say that although the mathematician appears to be doing nothing, nevertheless properly devised laboratory tests would show that the muscles of his

throat were making slight movements as though to say dy/dx, or perhaps the muscles of his hand as though to write it. The Behaviourist of course will not allow the poor man to have a mental image of dy/dx, because if he had, no laboratory test could demonstrate it and nothing is to be believed unless it is done in a laboratory.

But this theory about thinking consisting in slight movements or changes of muscular tone seems most improbable. Anybody who is mentally concentrating is liable to make bodily movements; some people just fidget, others are depraved enough to sing or whistle, others perpetually relight their pipes and so on. All this is merely blowing off steam. It is quite irrelevant to actual character of the thought process, it is merely a consequence of the fact that a state of central excitation tends to find some outlet. Besides there is the famous experiment in which a man did mental arithmetic while uttering " e-e-e " the whole time so that he could not possibly make " implicit " movements relevant to what he was thinking. There is no reason to suppose that either implicit or explicit movement is necessary for processes of thought and if movements are observed there is nothing to show whether they are relevant or not. There is however one point that is worth considering. It is quite possible that just as mental images on the cognitive side are something internal corresponding to percepts there may be something internal on the conative side corresponding to actual movement. These processes might not be apparent to the subject himself, nor be revealed as muscular twitchings or changes of tone and might constitute true imageless thought processes.

We may admit that every central process finds its fulfilment sooner or later in some overt act, but the act may occur later rather than sooner. In the meantime the thought is there and no muscular outlet is essential so that all contemporary muscular activities may be irrelevant. There is a state of internal excitation but it has to feed on itself in the meantime.

Is a central process which has no immediate outlet what we mean by thought? Probably not. A cat will crouch motionless for hours outside a mouse hole waiting for the mouse to come out. There is plenty of internal excitation, which occasionally finds an outlet in a lashing of the tail, but it would be a mistake to suppose that anything peculiarly intellectual was going on in the cat's mind or that it was even thinking at all.

Still it is customary to contrast thought and action and if the distinction is to be taken seriously the cat and the mathematician are both thinking and the acrobat is merely acting. It is more accurate to say that the action of the cat and the mathematician is delayed action and that of the acrobat is immediate or at any rate not delayed for so long. Now as a rule immediate action, action that is that follows a stimulus as quickly as may be, is routine action, using this term to cover habit, instinct, reflex response and what not; and certainly routine action is not thought. Whatever thought may be it implies breaking through routine and acting differently or not at all. This cannot be done without some delay but there is no reason to suppose that the length of the delay is significant. It would be quite legitimate to say that the cat, the mathematician and the acrobat all think when they first decide not to

do the obvious thing, when they inhibit the routine response Whether this thinking is of a higher or lower type does not depend upon the length of time that elapses before overt action occurs but on the kind of action that ultimately does occur and upon the character of the central processes that occur in the interval if we could find out anything about them. The final outcome of the cat's thought, if it thinks, is to eat the mouse and there is nothing to interest us in that. The final outcome of the acrobat's thought is a specially finely co-ordinated action and what is of interest in it is that it gives a certain æsthetic satisfaction to the performer and the spectator. This is hardly true of the outcome of the mathematician's thought which is probably writing down something on a piece of paper. There is no special fineness of co-ordination involved and nothing to give æsthetic satisfaction in the writing or in the sight of what he writes; neither are strictly beautiful in themselves. In fact what the mathematician writes down is simply a group of symbols, and this seems to be what is characteristic of his thought and action, that it is entirely symbolic. I would suggest that if the mathematician is going to claim that his thought processes are of a higher type, that he is more intellectual than the acrobat, not to mention the cat, he must base his claim on the symbolic nature of his acts and the results of his acts, and not upon his lack of activity.

If I am right in supposing that thought is essentially the interruption of routine response that fails to satisfy and the invention of something new in its place, then it is clear that many animals think occasionally and that many men never think at all in the whole course of

their long and distinguished careers. The contrast is not so much between thought and action as between routine action and new creative action. The mere fact that processes are purely internal does not make them mental, nor the fact that they are external prevent their being mental. But the internal processes may be symbols of past or future acts, and that is another matter. The study of the functions of the mind must culminate in a study of the symbolic systems that are the chief medium of thought, namely language.

Other Functions

Before concluding this chapter something must be said to qualify the statement made at the beginning of the previous chapter that the higher animals are primarily sensori-neuro-muscular systems. This statement is perfectly true but it must not be misinterpreted. All other organs of the body are of secondary importance, but they are there. The body is a single whole and no part is entirely negligible. The other organs are servants; but they may be unruly or contented; some may be over zealous, others may be idlers or inefficient. The virtues and defects of the servants will be reflected in the master's activities. Thus the general way in which a man or animal reacts depends to a large extent on the mutually correlated activities of the organs of internal secretion. The traditional classification of temperaments—Choleric, Sanguine, Phlegmatic and Melancholic is still of value, as Pavlov points out. The first is over excitable, the last over inhibitable. The other two are balanced types, the one tending however to excitation the other to inhibition. The differences may be due to a different

balance of internal secretions. If there is such a balance it is not likely to be entirely independent of the nervous system.[1] Similarly a man's activities and responses are governed by the rhythm of activity of the body as a whole. The rhythm may be externally imposed by day and night and the changes of the seasons, or internally by hunger and feeding, fatigue and rest, and the changes of growth and reproduction.

While considering all this it should be remembered that in this sphere similar causes do not always produce similar effects. Captain Webb swam the English Channel because he was a man of perfect physique. Lord Byron swam the Hellespont because he had a club foot; *because*, not in spite of having a club foot. Most men who become great orators have naturally a fine speaking voice and a flow of words. Demosthenes became a great orator *because* he had an impediment in his speech. It is easy to think of other cases It is true of course that most people can be relied upon not to kick against their natural endowment and lack of endowment, but the exceptions though few are very striking and are important for an understanding of the human mind.

Common speech and tradition have always tended to refer emotional states to the viscera, though there has not been much agreement as to which organs did what.

[1] There is a difficult problem here The activities of the system of organs responsible for the rhythm and balance of growth, reproduction and general metabolism are to some extent independent of the nervous system Some of the cells may be supplied with nerves of the autonomic system, some may not, but in any case the autonomic system controls their blood supply and so indirectly their activity. There is a useful analogy in the kidney. The kidney cells are not supplied with nerves but the kidney's blood vessels are, so that there is effective though indirect nervous control.

Views of this sort are not without scientific support. Visceral processes play a part in all violent emotional states. Cannon has shown clearly that *fear* and *rage* are accompanied by an outpouring of *adrenalin* and that many of the obvious bodily accompaniments are the result of its action. But there is no need to go so far as the theory of James and Lange that *fear* and *rage* simply are the bodily processes produced by adrenalin. Indeed if this view were true it would not be possible to distinguish the two emotions. It is more likely that Sherrington is right when he points out that *emotion* is what *moves* us and that it starts in the central nervous system. The visceral processes are essentially after-effects. In fear and rage they are very important after-effects because they enhance and prolong the process and adapt the body to meet the situation that makes one afraid or angry. The outpouring of adrenalin prolongs the state initiated by the primary stimulation even after it has gone, and makes it easier to maintain violent muscular activity. On the whole it is of advantage to an animal that if it starts fighting or running away it should do so as hard as possible and as long as possible. Though of course what is good for wild animals may be awkward for men who want to be civilized.

It is not easy to say whether similar considerations hold good for the other emotions. They are vague and less understood than these two simple violent emotions.

A very suggestive view has been put forward by Sir Henry Head, based upon human observations in cases of injury to the cerebrum, that the Optic Thalamus and neighbouring centres that lie just below the cerebral hemispheres are concerned with emotional reactions.

Or perhaps it would be better to say that these centres provide a coarse adjustment of the organism and that the cerebral hemispheres superpose on that a fine adjustment. In the absence of cerebral activity reactions are violent and prolonged but only coarsely discriminatory, often ill-adapted and liable to over action. The kind of man who bursts into a violent rage whenever he is thwarted in the least represents "thalamic" activity, whereas the normal person who takes things calmly and has more both of the wisdom of the serpent and the mildness of the dove represents cerebral activity. This view is somewhat speculative, and rests upon a rather narrow observational basis but it is certainly suggestive and throws a new light upon what is meant by emotion in general. The general notion of the cerebral centres as a fine adjustment and the lower centres as a coarse adjustment certainly has much to recommend it.

This notion has been further developed by Elliot Smith, who suggests that there is a kind of reverberatory connection between cerebral cortex and thalamus and also points out the close connection of the thalamic centres proper with the *hypothalamus*, the highest centre of the autonomic system.[1]

An attempt to summarize the functions of the higher centres ought to be made at this point. (1) Whereas the lower centres provide in general short paths between certain sets of ingoing nerves and certain sets of outgoing nerves, the higher centres provide long paths by which any ingoing and any outgoing nerve may be connected, and are thus integrating organs. (2) The

[1] A highly speculative treatment of this subject will be found in *The Neural Basis of Thought*, by Campion and Elliot Smith (1934)

cells of the brain centres are not merely passages. They have their own inherent activities which are modified by ingoing processes. (3) There may quite well be central activity unaccompanied by any relevant overt act but the absence of overt acts is not a sound criterion of central activity or of higher processes. (4) On the other hand the higher centres are often responsible for inhibition of the activities of the lower centres. In particular they may operate as a fine adjustment on the coarse adjustment of the lower centres. (5) Lastly they may be supposed to be essential for breaking through routine and initiating new types of activity, and thus responsible as far as a single organ can be for intelligence, reason and freedom.

Psychology must take account of physiology if only because the mind is an embodied mind and physiology is the study of its body. For all that attempts to construct "physiological-psychologies" have been vain. They have often turned on the quite childish fallacy of inventing imaginary brain processes, an easy thing to do in the absence of any specific information, and "explaining" psychological facts in terms of these fictions. But leaving this out of account, there are more serious difficulties. Physiological information, where it exists, is mainly in matters of detail, it is concerned more with the materials of which the house is built than the style of architecture. Psychology on the other hand is the study of the architecture, or it ought to be. The structure studied is the same structure but different aspects of it are being looked at by different methods.

Of course if body and mind were two complex substances interacting here and there and this way and

that way (or on corresponding parallel lines) then if we had detailed information about one side of the transactions it might be translatable into detailed information about the other side. Unfortunately the detailed information is not there and there is no good reason to suppose that body and mind are related in that manner.

CHAPTER VI

WHAT DOES PSYCHOLOGY STUDY?

EVERYBODY, whatever his training or lack of training, considers himself entitled to an opinion on Psychology just as he does on Politics and Religion. As a result Psychology suffers from still another disability, which it shares with Logic in this instance. People are not agreed as to what are or ought to be its methods and material and some think there is no such subject. Among the physical sciences there are no difficulties of this kind. They all begin at any rate at the level of ordinary common sense. Their subject matter is that of ordinary observation of the world around us, and their methods are those of the practical arts of civilization. But the position of Psychology is peculiar. In a sense it is as old as human language and older than any other science, if indeed it is not something more. Homer clearly knew a great deal of psychology (more I suspect than most modern littérateurs) and was quite ignorant of physics. On the other hand as the mind is not a material object available for observation, it is not clear *how* we can succeed in studying it. For Homer and his successors for many centuries, it is sometimes the heart, sometimes the breath, sometimes an apparition or ghost, sometimes a sort of shadow. They were never quite sure whether it was a thin sort of matter or not. Our nomenclature may be more refined than theirs but it probably conceals a similar uncertainty and confusion of thought.

It is not surprising that students of Psychology

should split up into "schools," each taking a different view of its subject matter, using different methods and despising all the others. There is no reason, however, for outsiders to rush into this family quarrel. If the different schools are actually all studying different things, they may all have genuine if limited information to give. Some of the antagonisms spring from philosophical differences and these are not likely to be reconciled.[1]

There are five main questions to be asked. (1) How far is human psychology based upon human physiology? The similar question about animal physiology and psychology may be left to answer itself if the one about human psychology can be answered. (2) Assuming that psychology is not merely physiology, does it make use of "subjective" data which the other sciences are not concerned with, and does it make use of a special process of "introspection" which again is peculiar to itself? (3) On what grounds can we distinguish psychology from other studies? (4) Is it necessary to recognize the existence of a group mind or of some sort of mental entities which are not simply the activities of individuals? (5) Is psychology a science like any one of the physical sciences or does it necessarily retain some extra-scientific characters?

Physiology and Psychology

Psychology has always had a very close connection with physiology because nobody in discussing the workings of the mind can forget entirely what he knows or believes about bodily structures and processes. To do

[1] For an astonishingly impartial survey I am greatly indebted to J. C. Flugel's *A Hundred Years of Psychology* (1933)

so would be to conceive the mind as disembodied and that nobody succeeds in doing. The "Spiritualists" are unwilling witnesses to this impossibility, for they try to describe disembodied minds and only succeed in talking about supernatural bodies. The relations between physiology and psychology, however, have not always been happy. Psychologists have had a knack of using bad physiology and using it in the wrong way (the physiologists have not been too helpful either).

It was unfortunate that the physiology of sense organs developed earlier than the psychology of sense experience. The trouble began as soon as it was realized that light and sound are processes transmitted through a medium from external objects to receptor organs and that nerves convey processes of some kind from receptor organs to brain. The facts had to be accepted by psychology but were accepted in a muddled way. Because processes in external material objects somehow cause things to happen in the brain the mind was supposed to be attached to the brain. Then the objects we are aware of in sense experience were transferred from the physical world where they belong to the mind which has no place for them It is only recently and with great difficulty that we are beginning to sort things out. Instead of putting the physical world (or part of it) into the mind we must put the mind (or part of it) into the physical world, certainly as far as this bit of it we call the body, perhaps farther. The mind is not a substance but a process : is not in a place but is a focus of activity towards and from a place, the place where the body is.

You may say that there is no great difference between putting the mind into the world and the world

into the mind, but there is. If we believe the world was there first the mind must belong to it. The other alternative as everybody knows leads direct to Solipsism, a theory that nobody can refute but that nobody believes.

If there was anyone who should have rejected all appeal to physiology it was Berkeley. Yet in the opening sentences of his *New Theory of Vision* he accepts a doctrine of physiological optics which he ought to have considered irrelevant. He says that " distance being a line directed endwise to the eye it projects only one point in the fund of the eye, which point remains invariably the same whether the distance is longer or shorter." On his own principles there is no *a priori* reason why distance should not be directly visible. It should be purely a matter for empirical observation. The plain man (to whom in other matters Berkeley often appeals) thinks it is directly visible and it is hardly possible to prove that he is wrong within the limits of Berkeleian philosophy. For what is the eye but a set of " ideas in the mind " and how can one set of ideas be a necessary instrument for the apprehension of other ideas? Sense perception for him ought to have been simply the contact of a disembodied spirit with God. Eyes, ears, hands, etc., are a superfluous tangle of confusions.

An instance of the difficulty of getting away from physiology even in the study of what are supposed to be " subjective " data or processes is afforded by those psychologists who have tried to find " pure " sensations unmodified by inference or memory or any external factors. As Kohler[1] has pointed out this quest has been dominated by a physiological theory without

[1] W. Kohler. *Gestalt Psychology*, 1930.

which there would be no motive to consider ordinary sensations impure and to look for pure ones. Actually these observers have fallen into the same error as some of the Behaviourists of using bad physiology and using it in the wrong way. The physiological theory is that the sense organs consist of independent receptors each of which has a separate connection with the brain and is responsible for a single, simple, "pure" sensation. The retina of the eye, for instance, was supposed to be a mosaic of independent receptors and visual sensations to be simply the sum of the processes in the separate receptors.

It is true that the eye does contain a mosaic structure of receptors which sometimes act and transmit independently and there are advantages in studying a complex of independent parts instead of an organic whole of interacting parts For this reason it is interesting to discover under what conditions the retina operates in a manner like a simple mosaic For all that the mosaic theory of vision as a general theory is false and can be shown to be so on anatomical grounds and from direct experience. The receptor cells of the retina are not connected to the brain by direct independent private paths but by way of ganglion cells with lateral connections. Probably there are no completely independent private paths from individual receptors anywhere to the brain. As far as the retina is concerned it is quite clear that it is a nerve ganglion with interlocking processes between receptors. So that the receptors can transmit independently only under special conditions.

The long familiar phenomena of colour contrast and those of spatial grouping brought out by the Gestalt

psychologists show that the anatomical findings are borne out by direct experience Two facts are worth noting in this connection. (1) When we attend to any object in the visual field and move our eyes and head about, all receptors in turn are differently stimulated and yet during the whole time we cannot avoid seeing one stable object with a determinate form and we

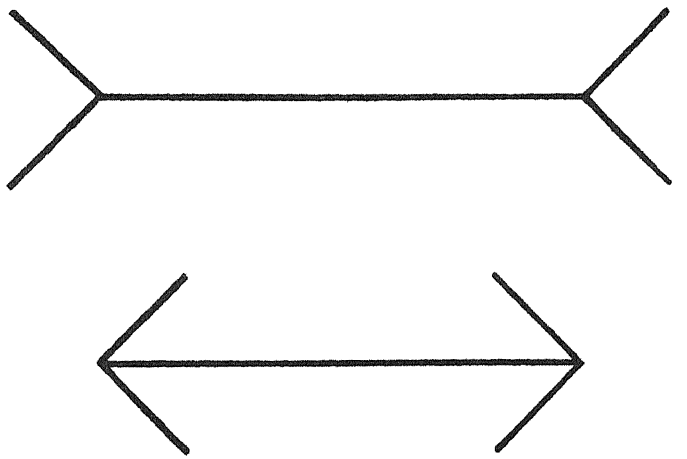

FIG. 1.

cannot by any means succeed in seeing a flux of shifting colours such as a mosaic of independent receptors ought to give us. (2) In the Müller-Lyer illusion (see Fig. 1) according to the mosaic theory the two lines stimulate the same number of receptors therefore should look the same length. Apart from this theory there is no reason why they should look equal. What actually happens is that the line belonging to the figure which takes up more space looks the longer; though why it does is not so easy to say.

There can be little doubt then that as far at least as

the psychology of sense experience is concerned physiological facts as to the mechanism of the sense organs and the working of the nervous system cannot be excluded and have not been excluded. This leads to the question, is the psychology of sense experience really anything but another name for the physiology of the human sense organs? This question is liable to receive the answer that it is different because psychology uses "subjective" data whereas physiology is purely "objective" in its methods and this is the next point to deal with.

Subjective Data in Psychology

The psychologist who is concerned with any aspect of experience or cognition reports what it is that he himself directly experiences and what it is his collaborators directly experience and how these processes vary with external conditions. This everybody admits, what is not so clearly realized is that every observer in any branch of science does exactly the same thing because there are no other data to report. The chemist describing a method of volumetric analysis says, "The end point is reached when, on the addition of one drop, the whole solution is coloured pale pink." He is describing certain relations he finds among elements of his own experience to guide others to repeat the experiment. The chemist is not interested in the pink colour itself or in the change from colourless to pink. He could perfectly well convert his observation into that of a spot of light moving on a scale by using a photo-electric cell or he could make his observation an auditory one with the help of telephone receivers. For his purpose the actual character of his direct experience

is immaterial as long as it changes in a regular way. He is using his senses as detectors of similarity or difference in the physical objects he is studying. The actual differences and similarities he detects vary with the way he arranges the physical objects beforehand and are of interest to him solely as detectors. In such an experiment there is no fundamental difference between a colour-blind observer and one with normal colour vision, though their actual colour experiences must be different. The colour-blind observer will get rather less accurate results and will be more likely to have recourse to indirect methods so as to avoid direct colour comparison if he can. But he can always get results equivalent to those of the other man if he wants to.

A physiologist who is studying visual processes is not in the same position as the chemist. He is interested in how the eye actually works and it is not a matter of indifference whether a change of colour is observed directly or indirectly by means of a photo-electric cell. Nor is he indifferent to the distinction between a normal and a colour-blind observer. The physiologist's primary interest is in the material apparatus of vision and how it works. For this purpose he uses his own direct experience and what others report about their direct experience as detectors of what is happening in their visual apparatus. So far he resembles the chemist.

The psychologist who is interested in visual perception resembles the physiologist who studies the apparatus of vision in so far as direct experience of one sort cannot be substituted for another sort and as he takes account of differences in the direct experience of

different observers. But his interest is not quite the same as the physiologist's. He does not generally care much how the visual apparatus works except that he has to allow for its limitations and peculiarities. On the other hand it is not quite correct to say that he is interested in the direct experience itself. Each element of experience as it occurs is the observer's private bodily possession and you cannot make a science out of private property even if you call it psychology. But you can make a science out of the relations between experience and that is what all sciences including psychology start from. The psychologist makes his science out of the way observers (including himself) respond to their direct experience, response including whatever they say and do and refrain from saying and doing. He differs from the student of the physical sciences in taking a direct interest not in the sense organs but in sense perception, the response to external conditions that is as a matter of fact mediated by sense organs. It is still true of him as of the others that he takes notice of direct experience as a detector of similarities and difference. All the different sciences use direct experience for detection : they differ in what it is they are trying to detect by its means

A large part of psychology necessarily deals with cognitive processes, processes that the other sciences simply take for granted. At any rate in the past they have taken them for granted, though recently the physicists have begun to feel a little nervous and introduce some discussion of the matter, not always with the happiest results. To study the process of cognition it is necessary first of all to state what are the objects of direct sense experience, the primary data, and then

how these are worked up to give the ordinary objects of knowledge. The other sciences assume these objects of knowledge to be all they profess to be and take no interest in the original data or the working-up process. To put the matter in other words; the physical sciences are concerned with the relations of physical objects to one another solely and as though undisturbed and undistorted by the process of observing them. Psychology has to take account of how the observer and his body are related to objects he observes. This is the only sense in which data are used that differ fundamentally from those of the other sciences.

The distinction between "objective" and "subjective" data rests upon a fallacy, the fallacy that the objects of direct experience are somehow "in the mind" and therefore "subjective" while the physical world is somehow "outside the mind" and therefore "objective" On the contrary the objects of direct experience are objective; they are constituents of that material world it is the business of physics to study. They are however constituents that physics does not emphasize because they are the world as seen from a particular place and physics aims at abstracting from any particular point of view. The psychologist cannot make this abstraction because the point of view is part of what he is studying. He is not more "subjective" than the physicist, he is more concrete.

This I hope disposes of the question of subjectivity. The other part of the question as to the use of "introspection" as something peculiar to psychology is not so easily dealt with and some considerable preliminary discussion is necessary as to what are the primary data of sense experience.

Primary Data of Sense Experience

At the outset it is necessary to point out that the problems of sense experience are easily misstated. The first and most fundamental fact is that though we have many diverse sense organs, eyes, ears, hands, etc., we apprehend one single perceptual field in virtue of their co-ordinated activity. Sometimes co-ordination fails and then there are anomalous experiences. These much discussed anomalies are secondary and derivative and need to be explained in terms of primary facts, not primary facts in terms of them. They are in themselves of no interest but are interesting as far as they may throw light on the co-ordinating process. For instance it is a primary fact of vision that having two eyes we see one visual field which coincides with a tactual field. We are not called upon to explain how two visual fields come to be fused because there are not two visual fields. (Possibly if we were horses we should have to explain this, but then we are not horses.) The phenomenon of seeing double is that of seeing two objects within the single field where there is only one physical object. The problem is made insoluble if it is stated without reference to the single field, as though the duplicated appearance were primary and the single one secondary and somehow produced by combining two things originally separate. This is a misstatement based upon the physiological fact that there are two retinal images.

It is necessary at this point to emphasize the distinction drawn by Broad between *inspection* of immediate objects of awareness and *introspection* in the restricted sense of an awareness of actual mental

processes as such. The term introspection as commonly used covers a disastrous confusion of two distinct processes. *Inspection* is a perfectly straightforward, *bona fide* activity, it is merely attending to what we are aware of at the moment, as far as possible without ulterior motives but simply to discover what is actually there to be aware of. It involves an effort of attention, analysis and abstraction, and it is not always perfectly easy but there is nothing about it that any honest man need be ashamed of. On the other hand some people have maintained that we can by an effort of *introspection* direct attention to the mental acts of perceiving, willing, desiring and so on, and thereby have a direct intuition of their characters, much as we have a direct intuition of the difference between blue and yellow when we look at coloured objects (i.e., *inspect* them). Others have strenuously denied that we can *introspect* at all and have tended in so doing to throw doubt on the process of *inspection* as a source of knowledge. This controversy will have to be discussed later. In the meantime it is *inspection* only I am concerned with. Inspection shows us three types of object. These are (A) the objects of sense, events, systems of sense data or whatever term you prefer; (B) mental images which appear to be imitations of type (A); (C) rather vaguely and indeterminately our own "feelings" or state of affective tone. These are not exactly objects, they are rather the "atmosphere" surrounding the apprehension of objects.

Taking type (A) first, among them we can distinguish two sorts, those that belong properly to our own bodies and those that belong to things outside. Sometimes the two sorts may be confused but generally they are

quite distinct and there are various ways of distinguishing in cases of doubt. When I look at something, what I see is outside my body but at the same time I see with my eyes and am aware of how I turn body, head and eyes to look at it. The pain from a blister in my heel is inside my body. What I can see on the heel or touch with my finger is not quite outside my body but is the outside of it.

The body counts partly as external world because it can be seen and touched like external objects and partly as self or mind because it is the means of perceiving and acting. Thus it has a crucial and ambiguous position. I suggest that we can go farther and say that it has not only a double aspect but a triple aspect in that it is a peculiar type of object for others. The world consists not only of "I" and "it" but also of "you." The body figures in all three positions.

What we appear to be aware of in sense experience can be grouped under five heads according to the kind of experience and where it appears *from* (remembering that appearances are sometimes deceptive). (1) Pains and certain visceral feelings appear as arising inside the body or at any rate quite definitely not outside. (2) Sights and sounds appear as arising from outside, with certain exceptions which sometimes produce illusions such as visual after-images and "singing in the ears." (3) What touches or is touched appears at the surface of the body, sometimes visually as well as tactually. These three groups between them delimit the body as having volume and a place among other objects, by supplying data as to inside, outside and surface. There are still two other groups. (4) Independently of touch and sight we are still aware of bodily posture and

movement, of our bodies as active and not merely passively recipient. Bodily movement also has the special character of altering the relations to external processes but not to internal processes. If I shut my eyes I no longer see, if I withdraw my hand I no longer touch, but no antics I can perform will separate me from a toothache. (5) Mixed up with awareness of posture, movement and contact is something that may be called awareness of causal relations. We are aware that what touches or is touched is causally operative on us or we on it. Moreover we do not experience loose sensations but one system of sensations of all sorts bound up with our own bodies as active or passive, harmed or benefited on the one hand, and on the other with things and people as active or passive. These apprehensions must in some sense be elements of immediate awareness, even if they are quite inarticulate. Certainly all instinctive actions are performed as though the agent had such a unified causal awareness.

The objection that there cannot be such a fifth kind of awareness because no specific sense organ is known to mediate it is very dubious physiology and downright bad metaphysics. It is not a specific sensory process using a special mechanism but rather from the point of view of life in general the common ground of there being any sensory processes and of being a living organism at all. It is a kind of *sensus communis*. On the other hand from the point of view of the percipient himself, it is a mode of awareness and not an *a priori* condition of awareness.

In sleep and in pathological states both the feeling of unity and of causal contact with an external world are liable to disappear.

I have linked together the feeling of unity and causality because I believe they are very closely connected, in fact, though of course logically the ideas are quite distinct.

In stating these views I believe I have some support from Whitehead. Part of what he means by "perception in the mode of causal efficacy" I believe to be what I mean. At any rate it was from him that I obtained the original suggestion of the incompleteness of sense data as ordinarily described. I think I can also claim support from Stout.[1]

Everything else that may be cognized is developed out of elements among these types of data by learning and by communication with other percipients. The recognition of and communication with other persons is an essential element in the development of cognition. For the present I am assuming that the source of this process of recognition is to be found among the types of data enumerated, but I am not prepared to deny that there may be other possibilities.

I have said nothing about smell, taste, temperature sensations and so on because these, though important from the point of view of pleasure and displeasure, are of less interest for cognition in human beings, except that they may be mixed up with causal awareness. In any case they do not alter the fact that what pleases or displeases is something sensed inside or outside the body or some bodily activity. Pleasure and displeasure are the main elements of the third type (C) of inspectable material. They must be dealt with later.

In addition to the data already mentioned *inspection* reveals a second class of entities very like them, mental

[1] *Mind and Matter.* Book IV Specially pp. 296-307.

images, which differ principally in the way in which they enter consciousness. The data of sense are able to obtrude themselves whether we want them or not; mental images come and go, to some extent, simply by wanting them and are not dependent upon bodily position and external objects.

These objects of inspection are what constituted the "furniture of the mind" for the older psychologists and were sometimes all lumped together as "ideas." Mental images, which have no recognizable relations with bodily processes, are about the most "mental" kind of object we can discover, if "mental" means "immaterial." Perhaps this character of images and the fact that images resemble objects of sense helped to persuade the older psychologists that objects of sense were also immaterial The mistake, of course, was to suppose, following Descartes, that if something was mental it could not be material and if material it could not be mental. Ideas are still the "furniture of the mind" but that is no reason for denying their right, or the right of some of them to be the furniture of the external world also.

The older psychologists also considered that mental images were intimately and essentially involved in processes of thought. Modern psychologists are less enthusiastic about them. The more extreme Behaviourists say there are no such things. Others less heroic, such as Spearman, admit their existence but consider them of no importance. We are told that they are not essential to thinking which may be image-less and that if present they are useless by-products. In fact visual imagery is characteristic of vulgar persons of low mentality. With education and the

exercise of intelligence it is said to disappear—like a cockney accent. If anybody says that he can think without images it is foolish to try to contradict him. But it is perhaps pertinent to point out that he is thereby debarred from direct apprehension of how his thinking processes go on, whereas another man who does have images may perhaps by attending to the flux of images, discover something about how he thinks.

Leaving mental images out of account for the moment we are left with the paradoxical conclusion that when we try to look into our own minds we are for the most part looking out to the material world, to external objects or to bodily processes. The process of *inspection* differs from ordinary attention in one respect only, that it is attention to what is immediately present without reference to past or future or what may be present but not actually observed. Otherwise inspection is nothing peculiar to the psychologist. When we inspect a mental image we may actually be observing a bodily process as when we inspect a pain, but if so it is a process about which nothing is known and about which it is idle to speculate. Mental images do not stand up to the process of inspection in the same way that sensations do. A sensation is obtrusive, it is able to present itself in virtue of some external source of energy. An image is supported solely by internal sources of energy and as soon as they are removed it fades. The mental image is there for a purpose and the purpose whatever it is is not that of being inspected. As soon as I start inspecting I have a new purpose for which that particular image is no longer relevant, so that it tends to disappear though not so quickly that I cannot get a glimpse of it if I really want to. This I

believe is the reason why images are elusive and are even thought to be non-existent, by those who do not wish to find them.

Whatever the causes of the appearance of mental images they are in form reflections of the world of sense experience and their function is to act as substitutes for objects of that world. They are internal in the sense that nothing external is known to happen to correspond and immaterial in the sense that nothing material is known to happen to correspond. If I have an apple in my hand I have no need for an image of one. But if there is no apple in my hand and I want to eat an apple the image may be part of the process of getting one, of recalling where the apples are kept and whether or not there are any left. My image of the apple is independent of known material processes but it does not follow that it differs in kind from objects of sense experience which are part of the material world.

The term introspection is sometimes used to mean simply the inspection of mental images. This usage seems harmless provided it is clearly understood that there is no fundamental difference between being aware of an image and being aware of a sensible object, and provided there is no confusion with the restricted sense of introspection to be considered shortly. As however there is risk of confusion and as there seems to be no special reason for having one term to describe inspection of images and another to describe inspection of percepts, this usage is best avoided.

Anybody who wishes to maintain that, considered purely as appearances, there is some fundamental difference between images and external objects has to explain away the well-known facts of Eidetic Imagery,

as well as the way in which images and external objects become confused in the state between waking and sleeping.

Introspection

The mind, as Alexander says, *contemplates* its objects but it *enjoys* its acts. Those who maintain that there is such a thing as *introspection* distinct from *inspection* are saying that the mind can contemplate its own enjoyment as distinct from enjoying its own enjoyment, which is quite easy. I would suggest that while we are aware that we enjoy, we cannot contemplate our enjoyment in such a way as to be cognizant of *what* the enjoyment may be, of its form, content, or relations. Self consciousness is a fact but not a fact that leads to knowledge about the self or the consciousness. To put the matter in another way; every fact or event has two ends, the " -ing " and the " -ed," to use Lloyd Morgan's terms. The " -ed " can be observed and scrutinized and from such scrutiny all articulate knowledge comes. Wherever spatial relations are concerned, the " -ing " includes the place from where the " -ed " appears and the place can be defined, not directly from the " -ing " but by means of other " -eds." Otherwise there is nothing very definite about it. As a source of information the " -ing " is not to be relied upon.

There is an important philosophical question involved which perhaps should be mentioned. If we admit that among the immediate objects of the mind's contemplation are to be found the mind's own activities it is very difficult to escape the final conclusion that there is nothing the mind can contemplate except its own activities. This reduces us to pure Mentalism. If on

the other hand we decide that the contemplative activity of the mind is directed towards objects which are primarily ingredients of the material world, we are committed to some form of Realism. Realistic theory will certainly be simplified if it can be maintained also that no object of thought whether material, like a stone or immaterial, like virtue, is ever an actual mental process, whatever its ultimate nature may be. Of course there is no reason to suppose that the universe was created to make things easy for Realists, but if such a position can be consistently maintained without denying plain facts, it is clearly in their interest for them to maintain it.

The conclusion that the mind does not contemplate its own acts appears to be difficult when pleasure, belief, anger and similar objects of thought come to be considered. If these names mean anything, they signify mental processes or acts. It is easy to suppose that we have an immediate and adequate intuition as to whether we are pleased, believing or angry and that this comes of observing something that is an object for self consciousness, or for introspection. The forms of language make it easy to speak of mental acts as though they were objects on a level with everything else and this has led many philosophers, as I believe, to tie themselves into verbal knots.

It must be remembered that there is a quite straightforward process of *retrospection* which may be palmed off as *introspection*. We may contemplate with the help of memory past objects of experience including our own bodily states as far as we are aware of them. Then in order to give a coherent account of what has happened we put in hypothetical acts or states of mental

activity. They are hypothetical in so far as form and content are filled in by this indirect method where previously there was only a blank space or a question mark. This can be seen clearly in the case of violent emotion such as anger. If I am angry I am not *introspecting* or *retrospecting* or even *inspecting*. If I manage to carry out what may pass as introspection it starts as a sort of question or doubt "What am I doing? Am I making a fool of myself?" As soon as I really think of the question anger is properly speaking a thing of the past. I am no longer angry, I am contemplating what I have just experienced. Besides within my present experience are certain slightly unusual bodily sensations which betray a fast-beating heart, flushed skin, and so on, and a general state of excitement. Combining this present sense experience with what I remember to have happened before, loud words and threatening gesture perhaps, I build up for my contemplation a theoretical construction which I label "anger" and conclude that I was angry. What I observe in myself are objects of sense that operate as stimuli and my behaviour in response, nothing very different from what I can observe in other people. I have no private insight into my own mind and my knowledge of my own acts is based on inferences just as much as other people's. My only privilege is direct acquaintance with my own bodily states, and a vague feeling that I am active.

When I am angry a spectator may have a much more accurate appreciation of my emotional state than I have myself. Afterwards when he tells me I lost my temper I may be surprised and even repudiate the suggestion until I have reflected on the circumstances.

It will be objected of course that it is unfair to argue from what happens in violent emotion, and that we do have immediate and accurate introspective awareness of calmer processes like pleasure or belief. As regards belief this is quite unconvincing. If the terms belief, disbelief, doubt, and so on, mean anything they describe ways of behaving towards situations. The situation may involve external physical processes or only words or mental images, but the belief is essentially a matter of behaviour. If I read a notice saying "This road is dangerous," belief consists in not going that way, disbelief in going that way, doubt in cautiously investigating the place. What I am aware of are certain objects and relations among them including certain bodily acts, also certain objects of memory. What I tend to call the mental process of belief are the internal bodily aspects abstracted from the rest. The case is not different in principle, it is only harder to investigate when there are no known or observable physical processes so that the objects are purely mental in the sense of being without known material correlates. When, for instance, I am trying to remember a word, the objects are all mental images and as one word after another comes before the mind it is rejected or accepted or doubted. I know that I doubt, accept or reject, because of the seen character of the image and its relation including its past relations. My immediate feeling of activity is an indistinct background that tells me nothing clearly but can be interpreted later in the light of future events. It is quite possible to be confused and misinformed as to believing, liking, desiring. We often conclude later, on reflection or retrospection, that what we thought we believed or desired at the time we really,

as judged by subsequent behaviour, disbelieved, disliked or did not want. The case of pleasure and displeasure as being the most purely internal and the most difficult to discuss provides a valuable last ditch for introspection, but, I hope, nothing more (see p. 237 *seq.*).

This brings us to the second paradox of mental life. The first was that when we try to look into the mind we see the external world and its reflections. The second is that to see into the mind itself to comprehend its acts the best way is to look outward to the behaviour of other people and to the interactions of their behaviour and our own. Human behaviour, then, is the only special subject matter of psychology.

This does not mean that the Behaviourists are right. Their mistake has been not only to use an entirely inadequate physiology but to wear blinkers so that none of the specifically human aspects of behaviour were visible to them. All the information that can be got from dogs salivating and rats running in mazes does not make up for neglecting the way in which men behave towards their fellow men. While we should not be too hasty to boast our superiority over our brothers the rats, where it is clearly demonstrated we ought to take note of it.

So far only the second question has been dealt with, and it is only the cognitive aspect of psychology that has been considered. Before dealing with the other questions it may be well to say something about the other aspect of mental life, the conative. I do not propose to deal with the matter systematically but only to consider one prominent recent development, that initiated by Freud.

The Psycho-Analytic Method

Behaviour in the form of overt action is the satisfaction of desire or the expression of emotion (whether these are different or not). This is an end product of mental activity, the manufactured article. To see something of the raw material and the manufacturing process we have to go farther back and consider what a person says as well as what he does. Language was perhaps originally simply an accompaniment of action that facilitated co-operation, as when men pulling on a rope say " Heave " all together. But it has developed into a preliminary to action and finally into a substitute for action. It provides symbolic satisfaction for what cannot be directly and simply satisfied. It relieves the tension of pent-up emotion in two ways, by providing a substitute outlet in symbols and by arousing sympathetic emotion in others. At a higher stage of subtlety it is an instrument for concealing emotions. Indeed it is one of the discoveries of the psycho-analysts that the extreme ambiguity of language symbols is not an unfortunate accident which could easily be put right by attention to the rules of logic and grammar but an essential part of their function. It is arguable that the symbolism of mathematics displays the ideal pattern of how the mind ought to work, but puns, jokes, figures of speech, slang phrases, show only too faithfully how it does work.

That is the reason why the procedure of the psycho-analyst is valuable—he lets the patient talk and makes him go on talking. A man's mind is his autobiography if you can get it out of him, both the parts he wants to publish and those he does not. The psycho-analyst

has of course another advantage, he has the opportunity of seeing the human mind in disruption and decay when certain elements, not normally visible, can be clearly seen. Of course the method has its disadvantages too, and it is impossible to read the literature of psycho-analysis without realizing them acutely. Even if these authors do not distinguish between fact and fiction and even if their theories tell us more about the working of their own minds than anything else they are always interesting—taken with a liberal dose of salt.

The difficulties are partly the teething troubles of an infant study but they come also from other sources too. Among these are the Idols of the Clinic. All who practise the art of healing have to cope with patients who come to them feeling ill and require to be made to feel better. For this purpose the prime essential is that the patient should believe the practitioner understands his case and is applying suitable treatment. The patient can hardly be got to believe this unless the practitioner believes it too. As long as they both believe, it is a matter of minor importance whether their beliefs are true. As long as individual patients seek out individual practitioners, whether for psycho-therapy or any other therapy, and pay them to be made to feel better, the art of healing remains a hopeless tangle of sense and nonsense (but there is another side to the story—to be mentioned later).

There is the further difficulty that the therapist who sees only the abnormal forgets what the normal is like.

There is still another and even more fundamental difficulty in deciding between fact and fiction in the work of the psycho-analysts. If somebody has broken

a bone and it has mended the evidence on the point is not confined to what the doctor and the patient may say about it, independent evidence can be obtained. But the statements of the psycho-analyst cannot be checked in any way. Even an independent analysis of the patient is no help because his mental state has been altered by the first analysis. In any case patients always supply the data the analyst wants to find, for obvious reasons

Even if one cannot distinguish fact from phantasy in the writings of psycho-analysts it does not matter very much There is perhaps no absolute distinction. All psychological theories are metaphors, as perhaps Freud has intended to hint by his use of Greek myths. In this sphere a fantastic theory is better than none It must be accounted to the psycho-analysts for righteousness that they have not been afraid to make fools of themselves. The academic psychologists have been so anxious to be respectable and to be treated as real scientists that they have never dared let themselves go. The result has been that they have produced dull myths instead of exciting ones, but they have been myths all the same

Consider for a moment one of Freud's theories, remembering that for all its absurdities it is probably a shrewder guess than anyone else has made. Freud considers that the Oedipus Complex is part of the make-up of the normal mind and not merely a pathological symptom. But as the theory is used by him it is able to account equally well for all possible facts. Does a child love and/or hate his mother and/or love and/or hate his father, or is he indifferent to either or both or does he love and/or hate anybody else? The Oedipus

Complex accounts for it all. Take any action (A) and provide a theory for it; then suppose the contradictory action (not −A) appears, the theory explains it as well or better. Suppose we are not Freudians but Adlerians or Jungians, then we do not believe in the Oedipus Complex but have other theories equally omnicompetent It is fatal to take these things too solemnly, but it is no good simply jeering and saying the psycho-analysts are illogical. So they are, but the human mind is illogical and was so long before Freud was born. It is Freud's merit that he has taken pleasure in drawing attention to it—*schadenfreude* in fact.

This does introduce a grave and perhaps insuperable difficulty. As long as you deal with cognitive processes and objects of consciousness, all is above board; the laws of logic apply and statements of fact can be checked As soon as you deal with what cannot be an object and the law of contradiction is left behind, any theory is as good as any other and in fact none are any good at all if they are taken as being more than picturesque myths. This must always be kept in mind.

The laws of logic may have some small influence on the cognitive processes, but the impulsive life of the animal *psyche*, which the psycho-analyst studies, cares nothing for them. The reason is simple, at the base of the animal *psyche* is a plurality, a mob of competing and conflicting impulses. Above these there is unity, but a unity constructed and maintained with effort and liable to decay and disruption. This unity is Freud's Ego. There is not just one plain straightforward integration, but integration may occur at different levels,

in different ways and with varying stability. There may even be rival integrations at work. Competition between rival centres of integration is likely to be a worse business than competition between simple appetites or impulses, which is bound to occur frequently. In any case simple appetites may be violent, but they are normally short lived. Each one dies down when it is gratified and easily passes over into its opposite. Even if it is not gratified it may die down and interfere no more. But the integrated unity, the Ego or part-Ego, is a more serious matter and may survive many vicissitudes in one form or another.

The integrations of which animals are capable are probably at a low level, feebly developed and more dependent upon external circumstances. That may be why animals seem to be less liable to serious mental disorder than men. The more complex the material and the higher the level of integration the more precarious it is and the more serious a conflict becomes. Here as elsewhere " le mieux est l'ennemi du bien."

Appetites, instincts and impulses on the one hand and Ego's or levels of integration on the other are all hypothetical entities introduced to explain the complexities of behaviour. They are not data of observation in ourselves or in others. Still whatever kind of theory is adopted it seems impossible to avoid this conclusion at least, that there is both a plurality and a unifying principle at work. To say that the instinctive and impulsive *psyche* is a plurality is another way of stating that the organs of the body are many and behaviour is adaptable and not merely adapted : any stimulus may give rise to any response or none. An appetite or impulse is just a general pattern of activity

which may or may not follow upon a certain type of stimulus situation or group of stimuli. If the response is almost invariably of one kind the organism is no more than adapted and there is no opportunity for conflict or any other complications, nor of course is there any opportunity for improvement in performance. Adaptability and the possibility of improvement imply a variety of impulsive elements, opposition between them, and possibilities of conflict.

It is well to remember that it is only when a response pattern is of a definite and positive type that it is given a name and if it has a name it is liable to be personified. The unnamed varieties may be just as important as the named. If a man sees food and eats it we say that is the appetite of Hunger at work. If he sees food and does not eat we might equally well say that it is because of the appetite of Anti-Hunger In any situation other than some of the most extreme and simple there are several alternative possible types of action each of which could be named and called an appetite or instinct.

Wherever behaviour as a whole follows some orderly pattern that is intelligibly directed to an end or set of ends we can legitimately infer a unifying principle or Ego at work. But it is a theoretical construction based upon the fact that what by itself might be chaotic is actually orderly. To conceive of the Ego as a sort of sergeant ordering about a company of half mutinous men is a myth, in some cases a useful myth, but not fully representative of mental life. Mind is a single unifying activity or principle, except in a few extreme cases when perhaps a couple of minds are at work in one body. It has no parts except metaphorically, but its integrity is always precarious

and is not maintained except by constant activity.

The first great triumph of Freud's method is the discovery that if we are the victims of a mental conflict we are not likely to know much about it ourselves. The more serious the trouble the less we are likely to know about it. If it happens that some impulse has been scotched but not killed, *repressed* rather than suppressed, something remains behind to interfere, but something that the conscious mind turns its back on. Like a "lady" snubbing a social inferior, the more the repressed impulse pushes forward the more it is not observed. Once the memories underlying the repressed impulse can be brought to consciousness the battle is half won It is completely won if the integrative principle is sufficiently stable to recreate the mental unity by properly handling what has previously been repressed or improperly handled. The Freudian conflict is an instance of the evil results of the wrong sort of compromise. It represents the occurrence at a high level of integration of a kind of defect that does not occur at the low level of reflex processes. It is what Sherrington calls *confusion*, as opposed to fusion or integration of different processes. The Freudian conflict is not the only instance of confusion at high levels but it is a very important one. It indicates a profound difference between high levels of activity and reflex processes and one that could not have been predicted on physiological grounds.

Freud's second great discovery is that repressed impulses, or it may be the repressed part-Ego, are able to find distorted outlets. They may find entry into consciousness under symbolic forms and a sort of disguised or vicarious satisfaction may be obtained.

This symbolism of the "unconscious," fantastic though it may be, follows a sort of rude logic of its own. When we are asleep and dreaming our mental life drops to lower levels of integration, for the time being we are removed from contact with the external world; then when the cats of consciousness are away the repressed mice come out to play their symbolic games. For instance a man who is to all appearance a devoted husband and himself believes he is may have a repressed hatred for his wife, due to some cause which he does not consciously remember. The repressed hatred may, if violent enough, hinder his normal activities and in any case is likely to find a symbolic outlet in acts that do not violate his feelings of respectability or rake up unpleasant memories. He may write to *The Times* complaining of the morals of the modern girl or he may dream that he killed the cat because she stole the cream. Even in normal people many of their satisfactions are vicarious and symbolic, for it is an inestimable advantage, even if it is dangerous, to be able to gratify incompatible impulses simultaneously.

It is easy to slip away from the world of reality and indulge in fancied internal satisfactions, and that way madness lies but more often merely futility (as witness most novels and the "Pictures"). On the other hand if it is rightly used this is the origin of the faculty of imagination which enables us to leave reality for a time to return again to a completer realization of it. If the power of inventing symbolic outlets for repressed desires is the source of mental disease it is also the source of all that separates man from the beasts for good or evil.

The theory in terms of which Freud has expressed his

views is confused and it will perhaps help to clarify matters to go back to what appears to be one of the sources, namely Plato's psychology. In *The Republic* Plato describes the *psyche* as having three aspects or parts. The lowest of these is the appetitive or impulsive, figured as a many headed monster.[1] The next is the mettlesome or courageous part figured as a lion, hardly a happy simile for us who know more about lions, but it is easy to see what Plato meant. The highest part, intelligence or *nous* is figured as a man, perhaps not a happy simile either, but let it pass. Each of these parts or aspects has its own characteristic excellence, temperance or moderation, courage and wisdom respectively. Plato's classification was based on "sociology" not on any pretended introspection, but he was also following an old tradition. Freud distinguishes three parts, the Id, the Ego and the Super Ego.[2] They are badly named. The Id, which ought to be plural not singular, corresponds to the many headed monster. Whether the lion would recognize himself immediately as the Ego I am not sure, but they both stand for the active focus of integration by means of which we are individual agents. If the modern thinker differs from the ancient it is not necessarily due to any defect in the ancient. In fact I would suggest that if we remember with Plato that courage is its appropriate virtue we get a clearer view of the Ego than most modern psychologists give us. Freud's Super Ego is essentially an ideal construction of what a person aims to be, something that provides principles

[1] "A multitudinous many-headed monster, having a ring of heads of all manner of beasts tame and wild which he is able to generate and metamorphose at will" *Republic* Book IX, Jowett's translation

[2] S Freud. *The Ego and the Id* Eng Trans, 1927.

of action rather than something that acts. Freud believes that the Super Ego is liable to be a stupid tyrant, a cynical view which Plato was far from taking of the *nous*, but otherwise the correspondence is fairly close.

Freud parts company from Plato when he distinguishes between the conscious and the unconscious. This distinction never seems to have occurred to ancient thinkers, because they thought of mind as the living agent and not as conscious subject in contrast with its objects Freud who differs from most other moderns unfortunately agrees with them in this. He says, in fact, that if anything is to be called mental it must be capable of entering consciousness in some form or other under suitable circumstances. Therefore if anything is unconscious there must be some reason for its being refused admission to consciousness. There is considerable confusion here, I believe, though I also think that the essential points can be stated without it.

An impulse or appetite is from the nature of the case unconscious, though if it has free play images and sense objects related to it as means to an end enter into consciousness. If I am hungry I think of food. If I see food it may make me hungry. If the impulse is completely suppressed, as when I desert my dinner because the house is on fire, anything connected with it leaves consciousness too. But if the impulse is only partially eliminated or repressed, it may in serious cases be able to find an outlet to consciousness only in a distorted form so that the corresponding images or thoughts are distorted too. It would be best, I think, to say that a repressed impulse finds an *involuntary* outlet and that accompanying processes in conscious-

ness and voluntary acts are related to it by means of an *unconscious symbolism.* Whereas for voluntary acts we can and do use the conscious symbolism of ordinary thinking. It is impossible to avoid using the word unconscious but it is desirable to restrict its use for this purpose to what might under favourable conditions be conscious and not to confuse it with processes which cannot themselves be objects of consciousness, namely, acts which are better distinguished as voluntary or involuntary.

Another ground for criticizing Freud, and Plato, is their fondness for the sacred number three, which implies a rigidity and definiteness that is unreal. At the basis of mental life there is a plurality of competing and alternating impulses or tendencies which need to be harmonized if life is to go on. In contrast with this many headed monster we may imagine a hierarchical organization for harmonizing or integrating which stands for unity as against plurality; though of course the unity may fail to work There are levels at which the organization usually operates and there is a possibility of its rising to higher levels. Its actual life will oscillate between certain extremes of level. It is natural but highly misleading to speak of this state of affairs as though there were two separate unifying activities—Ego and Super Ego—and still a third entity to be unified. Names of some sort have to be used, however, and if it is clear there is nothing sacred about it, the tripartite division is perhaps as useful as any.

It is easy too to pick holes in Freud's treatment of desire and the conative aspect of mental life generally. His use of the term *libido* in the singular is useful as

suggesting that there may be a limited supply of "energy" which may be turned in various directions, but it is misleading as suggesting a singular process rather than an indistinct multiplicity of processes. He is also guilty of the ancient error of confusing desire for an object or the attainment of an end with desire for pleasurable sensations; a confusion that often leads him and his followers into absurdities.

Destructive criticism in detail is easy because Freud, like other psychologists, has been unable to find any rational basis of classification in dealing with the impulsive or conative aspects of mind and has invented *ad hoc* such terms as seemed convenient. He has however, demonstrated beyond doubt that there is no "introspective" method of study. What is called "introspection" in this sphere merely reveals what the "introspector" wishes to find. The more we try to discover our own motives by direct means the farther we are likely to get from the truth. The only available method is "anthropological" or "sociological," observing how other people behave, to elucidate their involuntary acts as well as their voluntary acts and the unconscious basis of their thinking as well as their conscious thoughts. The Freudian psychology is an attempt to apply systematic methods of study to a subject that has hitherto been left as a happy hunting ground for the literary man.

It is worth noticing that although Freud was trained as a neurologist, his neurology has not helped him in any way: in fact his psychology started as a conscious revolt against the barren pedantry that passed as neurology in the nineteenth century.

One may ask at this point, has physiology any light

to throw on the matter? The answer I think must be, very little. On the side of sensation and cognition there are useful physiological data and they have been used, but not on the conative side; of appetites, instinctive impulses, desires, emotions, volitions, physiology has only the vaguest and scantiest information. Clearly visceral reflexes and other visceral processes come in somehow. About fear and rage something is known but what is known demonstrates that these are violent processes and tells us little else. Clearly the *autonomic* nervous system comes in. Some time ago great hopes were raised that the so-called psycho-galvanic reflex would tell us something but it remains little more than a parlour game. Clearly the *endocrine* organs come in too somewhere, but how or where? Pavlov's observation on the individual differences between animals in gaining and losing conditioned responses and of the "neurasthenia" that follows failure to discriminate between different objects all indicate the kind of lines along which physiological information may perhaps be obtained. There is no definite reason to believe that physiology is incapable of providing relevant and useful data but simply that the data are not yet forthcoming.

The Individual

There should be no difficulty now in answering the third of the questions asked at the beginning of the chapter. Psychology differs from the physical and biological sciences, but resembles all anthropological and social studies, in taking the individual, the human person as the primary datum. He is dealt with as a whole, not as a congeries of bodily parts. From the

physiological point of view it may be enough to say that the eyes see, the hands grasp, the legs walk. From the psychological point of view we say that *he* sees (with his eyes), he grasps (with his hands), he walks (with his legs) and we say further he speaks, thinks, desires, intends and so on mentioning if necessary and if known the organs with which he speaks, thinks, etc. There are many activities but they all have a focus in one centre, and their interest is determined by their relation to the centre.

It may be objected that this is not true of a very large part of experimental psychology, particularly the kind of study known as psycho-physics; that is to say finding the relations between variations in direct experience and its physical causes. As an example one may take the variation of visual experience with change in light intensity. In simple cases the results have been expressed algebraically. These formulae are open to serious objections, but whether valid or not they do show that it is not necessary to introduce the individual as a whole. The matter can be treated on a level with one of physical cause and effect.

It was in studies of the psycho-physical type that the great tradition of experimental psychology began in the hands of Helmholtz, Fechner and Wundt. The method, or a very similar method, has been extended to cover a very wide field of human activities, for instance the speed of memorizing nonsense syllables, the appreciation of musical harmonies and musical intervals, and in fact anything that can be recorded in terms of specific and regular response to physical stimuli. Now it may well be asked if there is anything psychological about this, apart from the fact that the people who do it

have called themselves psychologists. Is it not simply human physiology?

In favour of calling it psychology it may be argued that it is a study of how you and I react to external conditions in our capacity of conscious beings. But this argument does not seem to me to be a strong one. Quite low grade bodily processes may be conscious incidentally, as are coughing and sneezing. Nobody would call a study of the relation between irritation of the nose and sneezing psychology, it would simply be human physiology. Nobody would call an investigation of relation between stimulus and response in the knee jerk psychology although one may be conscious of the stimulus and the jerk. Notice that this is not generally conceived as a matter of arbitrarily making a distinction between two similar kinds of experimental study dealing with the same material. Presumably we speak of psychology where the *psyche* is involved and physiology where only separate bodily organs are involved. The appeal to consciousness seems to me irrelevant in this place. These studies have been called psychological mainly because the bodily mechanism concerned has been inaccessible and some directly observable product of its working has been used as an indicator.

I would suggest that the important criterion is not whether a process is conscious or not but the level of integration reached in carrying it out. Responses requiring a low grade of integration are much less psychological than those requiring a high grade. The knee jerk is less psychological than a sneeze, a sneeze than recalling nonsense syllables, this than a high grade "intelligence test." It is a matter of degree. All

these studies at least provide materials for psychology, the extent to which they are psychology depends upon how far the processes operate at a high level of integration. It depends also upon how they are interpreted, what they are used for.

There is now a much more important and difficult problem to discuss. Granted that the primary datum for psychology is the individual, is this the only datum? Many psychologists have played with the idea of a "group mind," a "collective unconscious," "racial memory." Some philosophers have postulated society as prior to the individual. Is all this merely the apotheosis of the "herd instinct" or are these hypotheses to be taken seriously as being possible even though not highly probable?

It might be answered that such a diversity of views has been put forward that they can safely be left to refute each other and certainly it would be a waste of time to examine any of them in detail. There must, however, be a reason or at least a motive for postulating anything of the nature of a group mind, and this is not very difficult to find. It is the fact that man is clearly a political animal and that individuals as members of a group do not behave in the same way as they do when outside the group. This is a sound reason for saying that social relations are not to be treated as purely external as between individuals, but as internal, so that each individual is in part constituted by his relations with others. It does not appear to be a sound reason for postulating a group mind, for saying that the individuals form the organs of an organism which has some kind of unity of its own.

Actually it is only the individual who is known to be

capable of free action. If there is such a thing as social progress or the advance of civilization it consists in liberating and raising individuals and there is no sign of an improved social organism developing. If ever there existed in the world an opportunity for the development of a group mind one would have expected it in ancient Athens, and the city's titular goddess may have been that mind. Nevertheless it was not Athena who wrote her literature but Sophocles, Thucydides, Plato and others ; nor Athena who built her temple but Pheidias and others ; nor Athena who saved her country from the Persians but Miltiades, Themistocles and the men who fought with them. While we cannot praise the grey-eyed goddess for any of these things neither can we blame her for the massacre of the Melians or the expedition against Syracuse.

There seems to be no good reason to suppose that any kind of group mind that has ever been suggested is anything more than the old tribal god dressed up to look like a scientific theory. The fundamental objection to tribal gods is that they were incapable of action and that there were too many of them. Perhaps if all mankind acted in co-operation like one tribe, things might be different ; but it will be time enough to discuss the question when they begin to do so.

A great deal of the futility of present-day discussion of social and political questions, I believe, comes from the unacknowledged and perhaps unconscious assumption that a society is a single organism in itself distinct from the members. Thus it is possible for a politician to get up and talk about the Honour, Security and Economic Needs of Ruritania, without exciting laughter and without anybody stopping to think that it is only

individual Ruritanians who can from the nature of the case be honourable, secure or have their economic needs satisfied. There are no instincts, desires, motives or interests that are not those of individuals and there are no other causal factors working within society than these same instincts, desires, motives and interests of individuals. It is easy enough to mock at these infantile errors but it must be remembered that they are the symptoms of a deep-seated complaint. Namely, that as yet no one appears able to give a rational account of the relations of the individual to society. As a result such a science as Economics hangs in the air without a proper psychological basis, its actual basis being the assumption that greed is the only human motive.

Without going outside the sphere of psychology as usually understood to look for trouble elsewhere, there are plenty of difficulties near at hand. Social life is based in the first instance on certain types of behaviour due to herd instincts, sexual instincts, parental instincts and probably many others to be named and arranged as you will. Nevertheless, human society in its later developments is not based exclusively on the mutual linking up and clashing of instincts or desires derived from them. To consider the difference it is necessary to introduce two distinctions that have been discussed by Professor Stocks.[1] They are very closely related. One is the distinction between *desire* and *affection.* Desire is purely general; it is for a kind of action or object, not for anything individual. In a restaurant you order *a* chop and you do not repudiate the one brought because it is not the individual chop you are

[1] J. L. Stocks, *The Limits of Purpose and other Essays*, 1932.

looking for. If you repudiate it it is because it is not the *kind* of chop you want. Affection however is directed towards the individual. A man loves *his* family, *his* home, *his* friends, *his* country, as individuals, and cannot possibly love *a* family or families or even The Family. We say (possibly falsely) that an animal's sexual instincts lead it to find *a* mate at the proper season. But if a man's relations with the other sex are conducted entirely at this level we use rude words to describe them; the politest thing that can be said is that it is a pathological case. Clearly a bundle of desires does not suffice to make up a human person, nor do the interactions of desires suffice to make up human society.

This brings us to the second distinction. In terms of *purpose* action is merely means directed to an end and is considered as though external to the end and of no interest in itself. If the end could be attained without the action there would be no action. A man will work to get food but if he could get the food without working he would not work, in so far as the work is merely a means directed towards food-getting. Though human action is obviously purposive, this is inadequate as a complete account of it. Actions may be described as good or bad, right or wrong in themselves quite apart from the question whether they are means to an external end or not. A man may sing in order to earn money but that is seldom the sole or even the chief reason for singing. Moreover there is a clear sense in which his singing may be called good or bad quite independently of how much he is paid for it. Singing well on one occasion does not obliterate the badness of singing badly on another occasion, apart from the secondary

point that a man must practise his art and improves by practice. It is each particular song that is good or bad and it is good or bad in itself absolutely without reference to anything coming before or after.

I have taken a simple illustration, but it is easily seen that in general æsthetic and moral judgments are valuations of individual acts or processes themselves, not as means to ends other than themselves. A merely purposive act is of no value in itself; it is the kind of act that is successful or the kind that is unsuccessful that is all.

Thus from two points of view it is seen that any full account of human behaviour and human persons must rest on the individual, on individual persons and individual acts Now the individual and particular can never be caught in the net of ordinary scientific method, which holds only the general. Psychology is and always has been an empirical study. It always has and always must make use of all available scientific data. Nevertheless it is not and never can be purely scientific, in the sense in which Physics or Physiology are purely scientific, without giving up the attempt to study and understand the individual person.

Assuming that there are " laws of mind," that are not just laws of bodily habit, they will be illustrative, providing general principles of interpretation not necessarily legislating for the individual. For in any particular case there are alternative possibilities to take into account. Regularities of stimulus and response have no necessary connection with mind at all and they too are limited by the fact that ultimately any stimulus may produce any response.

Psychology is assailed on one side by the fanatic

who must be " scientific " at all costs and thinks he is being so as long as he is measuring and using algebraic symbols, even when he does not know what he is measuring or what the symbols stand for. To him human persons will always be closed books. At the other extreme is the fanatic who may be a successful clinician, who does understand and can deal with individuals but who has no general means of expression except the shibboleths that are his magic wand to impress patients with. In between these extremes lie all reasonable psychologies. In part they will consist of something like the laws and theories of physical science, in part of that actual acquaintance with individuals without which generalities remain empty and meaningless.

At the risk of misunderstanding and unpopularity I would maintain further that psychology, a large part of it at least, must be intimately connected with philosophy, as in the past. It may be thought that the pupillage of psychology to philosophy was merely a misfortune of youth, that as soon as she was grown up and had a technique of her own, like the other sciences, she would escape from these step-motherly hands. I believe this is a mistake, and the two are inseparable. There are two philosophical problems that are also psychological, the problem of knowledge and the problem of conduct. As to the first, the philosophical part of the problem is that of the validity of our supposed knowledge but that is inseparable from the problem of the actual historical process of acquiring knowledge which is psychological. Again, it is absurd, to discuss the actual process of acquiring knowledge without mentioning its validity. As to the second problem, we cannot discuss how men ought to behave without knowing how and why they

actually do behave. Nor can we discuss how and why they behave without mentioning the fact that they believe, however mistakenly, that some kinds of behaviour are right and some wrong.

It is often said that the anthropologist, for instance, must merely state how the natives of the Fiji Islands or the British Islands actually do behave and must never pass moral judgments on their behaviour. It is urged that he must not say that the custom of tattooing the face or that of applying pigments to its surface is good or bad, and the results beautiful or ugly; and undoubtedly he is very rash if he does say anything of the sort. On the other hand if he is a conscientious observer, he must report that the natives of these islands do themselves pass such judgments and he cannot avoid considering what, if anything, they mean by it. Sooner or later, if he does his work thoroughly he gets involved in philosophy. If he supposes he is not so involved it is because his philosophy is unconscious. Great as the virtues of the "unconscious" may be, it is not the best place for keeping philosophies.

Summary

So far the main points that have been put forward are as follows. (1) As far as physiology provides relevant detailed knowledge about the body, psychology as the study of the embodied mind must be based upon it. (2) Psychology has no peculiar source of information of its own that in principle is not available for and used by other sciences. (3) Where psychology differs from other sciences is not so much in the kind of things observed as in the use made of them, the conceptions by which they are ordered. (4) The individual

person is the primary datum for psychology. The questions asked at the beginning are therefore answered (after a fashion), but there is still a further subject to discuss. As things stand at present there is a fairly clear distinction between physiology or any of the biological sciences on the one hand and psychology or any of the anthropological or sociological sciences on the other. Is this existing division either necessary or useful?

If, as has been suggested, the criterion of psychological study is that it starts by taking the person as a unit, as a complete whole, while physiology takes him as a bundle of organs, this makes of course for considerable differences of technique in investigation and more important still for fundamental differences in the intellectual concepts used and the methods of interpretation.

As has been mentioned already it is not always easy to distinguish experimental studies in human physiology from those in human psychology although in principle a distinction can be maintained. Moreover in physiology and the biological sciences certain psychological or at least anthropomorphic conceptions are used, the teleological notions previously discussed. It is doubtful even whether the notion of an organism as a unit could have originated except anthropomorphically. (We need not enquire at present whether the categories of cause and substance even are safe from this accusation.) The introduction of anthropomorphic notions would be illegitimate unless there was some close affinity between the study of organisms by experimental physical methods and the study of the behaviour of human persons by any methods. Of course some will say there is no connection and these notions are illegiti-

mate. The work of Freud has been quite independent of physiology but there is no inherent reason, apart from the present backward state of physiology, why it should be. In a word, I doubt whether there ought to be any radical difference between physiology and psychology except what should be the minor one of distinguishing the study of the parts from that of the whole of which they are parts. What I want to know is why there appears to be such a radical difference. It is not entirely a matter of technique or of preoccupation with animals as against men.

The reason I believe is to be sought in the traditional dualism of structure and function. Whatever the physiologists may say they are doing, they have in the past been mainly concerned with structure. Structure has been conceived in terms of the classical physics; that is to say it is the spatial arrangement of indifferent and inert bits of matter. Function has been conceived as simply movement superimposed upon a pre-existing arrangement. If this is not merely an arbitrary convention and abstraction convenient for certain purposes but is really the last word, then clearly not only cannot physiology and psychology form one science but there is no real common meeting ground for them. Furthermore, if the physiological method can never be properly speaking synthetic, can never deal with an organic whole as such but only with separable parts, then again there is no genuine common ground between the two studies.

However let us for a moment try to get behind the familiar abstraction of structure and function, which is at bottom merely a question of what changes slower or faster and try to get beyond the classical concepts of

matter. An organism in its whole spatio-temporal extension is a system, or rather, an ordered stream of events, forming a centre of order in the middle of what is disorderly or only partly orderly in so far as other organisms are present also. The distinction between one part of an organism and another is absolute and definite at an instant only, and comprehensible at all over a short period of time. The organism over any length of time is essentially a coming and going between the different parts. Nothing happens in one place without it reverberating in other places and these echoing back in turn. This interchange is what keeps it all together as a unit and yet spreads it out in its environment. Looked at from this point of view there is no reason to suspect any fundamental distinction between physiology and psychology. The organism is the way it behaves and it behaves as a whole. As long as the study of any partial process is carried through to the end and does not stop half-way it will give a view of the whole from that aspect at least.

Of course it may be impossible to carry out a programme of this sort. It is possible that the old abstractions are essential for the use of the kind of laboratory techniques that have been developed for physiological purposes. If this is so both physiology and psychology must remain truncated.

Most of what passes as experimental psychology will be only a dull branch of human physiology. Psychology as such will hardly exist as a science or part of philosophy or as anything else. I only hope this is not true.

CHAPTER VII

SENSATION, PERCEPTION AND COGNITION

It is often supposed that there is no difficulty at all in enumerating and classifying the immediate objects of sense awareness. We have only to attend to the things before us at any moment in order to have an immediate infallible intuition that they are colours, shapes and so on. This simple faith can hardly survive careful consideration. In the first place the usual analysis of the objects of sense awareness is based upon our supposed knowledge of the structure and mode of operation of the sense organs. When we look at a table immediate intuition, as far as there is such a thing, tells us we see not merely a coloured shape but something hard and smooth (in fact a table). From our knowledge of sense physiology we infer that hardness and smoothness are invisible and correct our first rash assumptions. In the second place, it is not easy to distinguish between what is actually at the moment an object of sense awareness and what is only an imagined though possible object of awareness, and the distinction is not as a rule clearly drawn. There is even liable to be some confusion with objects that are conceptual and inherently incapable of being objects of sense awareness as when we say we *see* this is a writing table and we *see* that is a dog. At every stage intuition, or what we take to be such, and scientific analysis are at loggerheads. Intuition gives way to scientific analysis but by way of recompense its supposed immediacy and infallibility are surreptitiously transferred to certain

atomic residues, the elementary sense data which are left standing when the analytical process has done its disintegrating work. The state of affairs is as curious as if we concluded that we were not acquainted with chalk but only with calcium, carbon and oxygen (and traces of impurities), nor with cheese but again only with carbon, hydrogen, oxygen, nitrogen, sulphur and phosphorus (and larger traces of impurities). Consequently our knowledge that the two taste differently must be an inference from these primary data. Men of science have been known to talk like this, but their example is hardly one to be imitated.

It is no wonder that the subject of sense perception is a thorny one. What makes it worse is that it is one of the great battlefields of the philosophers. It always will be one because it holds the key to their strategy. This is very disturbing and sometimes even disastrous to the psychologists who only want to cultivate the land in peace It also upsets these philosophers who retain old-fashioned scruples about sparing non-combatants. But that is the situation and we must make the best of it.

If the views I have to suggest are here put forward dogmatically and without sufficient qualification it is done for sake of clarity and simplicity and not because I am labouring under the delusion that they are the last word on the subject.

It is pleasant, or aggravating, according to our point of view, to reflect that there are to-day no data and no conceptions concerned in this discussion which were not, in outline at least, available when Socrates discussed it with Theaetetus. We possess now the sobering knowledge that everybody, always, through all

these centuries has got it wrong, but otherwise we are no better off than Socrates.

Perceptual Geometries

Sensation is generally understood to mean the apprehension of the simple qualities of what is present in the field of awareness ; as that a piece of paper is white and of a certain visual shape By discriminating within or analysing the sensory field we can (it is said) reduce what we find there to simple constituent elements, *sensa*. The *sensa* of sight are coloured shapes or shaped colours and nothing else. Even if we accept this view, it still remains a fact that *sensa* are not the original raw material of our information about the visible or otherwise sensible world. They are more like manufactured articles. *Sensa* cannot come first in the process of generating knowledge. At the best they are the result of applying an intellectual process of analysis to our already developed knowledge, and are two stages removed from the raw material, whatever it may be in the raw state. At the worst they are fictions invented to justify the mosaic theory of retinal processes and other similar theories about the sense organs. The process is objectionable even if the theories happen to be right ; and these are not.

Nevertheless the general method of analysis is not entirely vain, although the results are liable to misinterpretation. In order to construct a rational geometry of the visible world some process of this kind is inevitable and is useful as long as it is realized that *sensa* are idealized entities, like the points and straight lines of Euclidean geometry. No material object is composed of points or straight lines and yet the propositions

of this geometry are applicable to material objects. It may be hoped then that although no visible object is actually made up of *sensa* or contains them theories based on *sensa* may be applicable to them.

The task of constructing a Geometry of Visibles was begun by Berkeley in his *New Theory of Vision* and has recently been carried much farther by Prof. H. H. Price in his book on *Perception*. Price has shown in some detail how starting from visual *sensa* a rational theory of perception of visible objects can be constructed Perception may involve more than Price says it does, it cannot very well involve less.

Another geometry has to be constructed also, a Geometry of Tangibles. As Berkeley was aware, although our apprehension is combined in one total field we have no immediate intuition of relations between the objects of sight and touch, we have to discover their relations by trial. The two geometries therefore are connected in an empirical fashion. The relations need to be stated explicitly, but once stated a combined geometry can be constructed, a geometry of perceptual objects, which should be the basis of the geometry of objects of *cognition* as developed in physical science. Whitehead has supplied the principles for the construction of a cognitive geometry. Thus it is possible to say in outline what sensation, perception and cognition ought to be when their logical relations have been properly set out, and assuming that their elements are known. To set them out is a pleasant task for future workers who can start where Whitehead and Price have left off.

Unfortunately this is not all. It might be all if physical science could be reduced to Kinematics and if

physical science covered all cognition. The world we live in is not only a world of *percepts* but also a world of *causes*, a world which acts on us and on which we act. Perception is the thread that guides us through the labyrinth, but there are other things in the labyrinth besides thread. Perhaps there is a causal geometry to combine with the perceptual geometries, or else it may be possible to introduce causal terms into the geometries. Indeed this is what the physicists have done in the past Newton's law of gravitation was a causal law imposed upon the geometry of space.

In the logical development *sensa* as the simplest elements come first, in the historical development the order is different. At any rate *sensa* and sensation come last. What comes first is not cognition but the germ out of which cognition and all the other processes and their objects develop. There is here a difficulty that cannot be escaped. The historical and the logical order are different but not entirely separable because a thing is what it has grown to be and is growing to be. It is never solely what it may appear to be at any moment.

Before we can be aware we must be alive. The world we live *in* is a causal world in which as organisms we are both causes and effects. The world we know *about* is primarily a perceptual world. Perception is a causal process, it is true, but of a very peculiar kind. The green plant sends leaves upwards in response to the light and its roots downwards in response to moisture. This is a kind of causation, it is also the way in which the plant after its fashion perceives or cognizes the world. It is a seed out of which perception and cognition may grow. The primary response to the

operation of an external cause is not a perception but an *affective state*, pleasure, displeasure, excitement, depression, fear, anger, concupiscence and so on. Perception and cognition are special further developments.

Analysis of Experience

All experience is incomplete; any one bit bears a reference to other bits. The reference may be *de facto* or *de jure*. By *de facto* reference I mean that every volume or extent experienced however large has something outside it actually or potentially. Temporally our experience is bounded by birth and death, but the universe bears signs that it was not created at our birth and is not likely to be annihilated at our death. Spatially experience is bounded by the capacities of our senses and the instruments with which these capacities can be extended Beyond anything we do perceive are other things we might have perceived or may perceive. A particular instance will show this clearly. If I am awakened from deep sleep by a clap of thunder, there is a moment when it seems to constitute the whole universe for me. Before it there was nothing, now there is nothing else, only a vast noise. This is the nearest I can get to an experience which is complete and not a fragment, but after this moment is over I realize it is not the whole universe, other things have happened before, are going to happen and are even now happening. The noise is an element within a universe of other events and that universe has no definite boundaries. Within it every element has reference to other elements *de facto* simply because they are there beside it.

There are in addition *de jure* references because there are similarities and regularities discernible so that one

element may symbolize or suggest others. If I recognize the noise as a clap of thunder that provides a whole host of references depending upon what I know, believe and imagine about thunderstorms, and this particular clap of thunder is seen as a fragment *de jure*. This means that no experience is complete. Anything may have undiscovered relations.

The reaction produced by being awakened by a sudden noise is equivalent to an assertion and three questions : (1) There is something happening : (2) What is it ? (3) What is it going to do to me ? (4) What am I to do about it ?

The assertion (1) is not " I hear a noise " : for that is a more abstract statement and is the result of analysis. What I am immediately faced with is something noisy as part of the universe or else, to be Bradleian, the fact that part of the universe is qualified as noisy. The " I " does not really come in at this stage for there is nothing to differentiate " me " from the rest of the universe. There is an " it " before there is an " I " The " I " comes in later with questions (3) and (4) as a process or region of stress between feeling and doing. If we could stifle our greeds and anxieties and remain at (or attain to) a state of pure contemplation then there would be no " I," or nothing to speak of. It requires an effort of analysis and abstraction to hold the " I " and the noise apart from the world they live in and say " I hear a noise " instead of saying " There is something making a noise." The only way in which anything approaching the " I " comes in immediately is in the reference to place that is implied—a noise *over there* is heard *from here*.

A state of pure contemplation does not last long,

even if it occurs at all. Most things are looked at solely with regard to how they help or hinder our purposes. I do not usually contemplate the clap of thunder as such but consider it as a sign of something that may or may not do harm. It is an object of emotion even before it is an object of cognition. I cognize it by judging what are its relations and whether it is a sign of anything harmful or beneficial.

The question "What is it?" may be answered by analysing the situation as it exists, finding what recognizable elements it contains and how it develops. This does not necessarily mean passive waiting. I may get up to see what is happening. In any case if what is happening affects my comfort I proceed to take action accordingly; if it does not the whole thing fades into insignificance. What does or may hurt or benefit is a *thing*; what does not is merely the background of things. If there is something that has appeared prominently, like a loud noise, it fades into the background most readily as harmless and uninteresting if it is successfully recognized and placed in the ordinary causal world. As long as I am doubtful about what the noise signifies it is an object of fear to some extent. An unplaced thing is always worse than a placed thing. If a noise of that special kind never occurs again or if it goes on occurring but is never accompanied by hurt or benefit then it will tend to fade into the background whether placed or unplaced.

This is the attitude of the animal and the "plain man," but not of the man of science in pursuit of his science. His attitude is the peculiar and unnatural one that every phenomenon may be a "thing" and that everything is of interest whether or not it is harmful or

beneficial. To the biologist every animal that comes up in the fisherman's net is equally interesting and every one has a name. The fisherman only has names for what he can use or sell or what may tear his gear or hurt his hands. For the rest he has no name and he does not see them as separate entities. They are merely so much qualified muck that has to be shovelled overboard. For the plain man the world holds no obscurities, very few uncertainties. He knows all he wants to know and beyond that there is nothing; practically nothing. It is the pursuit of science that creates problems and obscurities.

Symbolic Nature of Experience

Naive Realists in the sense in which philosophers have used the term do not appear to exist. The naïve man is not a realist in the ordinary sense of holding that whatever appears is equally real. He is a Symbolist. Appearance is appearance of the real when it is the sign of a *thing* and a thing is what has power or is causally efficacious. No appearance is real in its own right, but only at second hand. To a child a penny is not something hard and round, nor yet something brown and of varying ellipsoidal shape. These are the signs of a penny and are not noticed for their own sake. The penny *is* simply what will buy a penny-worth of sweets. This of course is precisely how the Economist defines a penny, except that he says "goods" and not "sweets," but the principle is the same. The science of economics is the rationalization of what the child and plain man think about the penny.

It is thus that a distinction can arise between the penny as it is in reality and as it appears. Naïve

thought does not draw this distinction clearly and steadily but in so far as it does distinguish, the real is what has power, the apparent is of interest as a sign of the real. What has no power is not real, and if it is not even a sign of the real it scarcely appears but remains as a background to appearances. To say that the apparent is a sign or symbol of the real, means that the relation between them is imposed by a mental act, either deliberate or merely habitual. The sign, whatever it is in itself, is made to stand for or be equivalent to the significate in certain relations. The relation of sign to significate need not imply any further relation. In this case, however, of apparent and real objects it is often assumed that there is also a "natural" relation, causal perhaps or more probably one of identical location in space and time. However this may be, the apparent and the real must not be consigned to different worlds, they must somehow form one world together.

An object may appear in two ways: it may appear at a distance or in contact with the body. Usually it is only what touches us or is manipulated by us that harms or benefits. Hence the child's preference for a penny in his hand as compared with a penny at a distance, that is out of control. Hence also come the physicist's suspicions about "action at a distance." Appearance in contact with the body, mainly tactual and motor but also visual, constitutes a *symbol of the first order*: that is to say it directly symbolizes a *thing* which is causally efficacious, and defines the mechanical properties of the *thing*. Appearance at a distance, mainly visual, is normally a *symbol of the second order*, it symbolizes a first order symbol. Visual appearance at

a distance is normal and a second order symbol when it is veridical and not illusory, or, as I should prefer to say, *simple*. What are called illusory appearances or, better, *complex* appearances are *symbols of the third or higher orders*, according to the degree of complexity.

Perhaps some explanation is necessary. *Simple* or veridical appearances are such as symbolize an object correctly by reference to the object and the percipient simply without reference to the intervening medium or any other third factor. Complex or illusory appearance can be interpreted correctly to symbolize a second or first order symbol only if another factor or other factors are considered. When I look at a penny under normal conditions what I see correctly symbolizes the real penny according to certain simple rules that involve only my own bodily position and that of the penny. I can predict correctly that certain movements will enable me to pick it up, that when handled it will feel as I expect it to feel and, the final test, that I can exchange it for a penny-worth of goods. If on the other hand the penny is under water or is seen in a mirror the appearance is illusory as long as I fail to consider the water or the mirror as a third factor besides myself and the penny. Acting according to the simple rule of the first instance I shall fail to pick up the penny, but acting according to a more complex rule which involves the water or mirror I can pick up the penny quite easily. There is no *illusion* unless I think the situation simpler than it is. It is easy to imagine situations of any order of complexity up to the pink rats seen by drunkards, which must be symbols of a very high order. This account covers, I believe, the ordinary cases of illusions of sight and of other senses, but not necessarily all

hallucinations or illusions due to confusion between sensory images and sense objects. Though these can probably be dealt with on similar lines; the illusion is due to a misinterpretation of symbols and that is likely to be the result of over simplifying the situation and neglecting a relevant factor. Of course every situation is over simplified in that it is incompletely explored and experience of it may in the end yield something contrary to expectation.

Real food is what satisfies hunger and, perhaps, gives me a pain later on, but nourishes me in the long run. The food I pick up and chew is the first order symbol of this real food and is so closely related that most people take the real thing and the first order symbol as being one and the same. The case of the penny shows that they are not. The penny will buy things only in the country of its origin and only while the currency is reasonably stable. It is easy to see that the penny in my hand is only a sign and an arbitrary one Whether or not the bread we chew satisfies hunger does not depend upon the vagaries of governments and speculators but upon the mechanisms of our bodies which are more stable, therefore we are not so ready to distinguish between the sign and what it signifies.

It might be thought that science is concerned with appearance only, with the signs and not with the things they signify. Indeed if Kinematics were the whole of Physics we could go farther and say that it dealt only with the spatial character of second order symbols or visual objects. Those thinkers who lean towards Positivism or Phenomenalism undoubtedly attempt to make some such reduction and they are in the

Cartesian tradition. But as is well known the experimentalists themselves have never followed the tradition and would probably have discovered little if they had. Dynamics takes account of factors such as *inertia* which is a tactual and motor property of things (their " pushiness " as Whitehead says). It also takes account of *energy* which is derived from the notion of causation, the essential property of *real* things, as far as physics can take account of it, as opposed to their mere appearance. Thus there has always been an appeal to a *real* world at the back of scientific theory. Consider what is meant by asking whether or not atoms or electrons are real? If they are not real they are mere symbols and if they are symbols they must be symbols of something. The question means, are atoms themselves causal or are they only symbols of other things which are themselves causal?

Nevertheless it remains true that the appeal to the real world of causes occupies a rather uncertain position at the back of scientific theory and is not firmly placed in the front of it. Scientific theory for the most part is in terms of appearance, perceptual symbols, and is bound to be because critical observation is observation of appearance and specially of visual appearance. But it is never entirely visual appearance. Measurement turns in the last resort on placing the ends of a scale which is hard and solid in contact with something else hard and solid. All construction and manipulation of instruments depends upon muscular activity and the causal properties of actual things. The instrument is what I do to it and it does to me. Scientific theory puts the appeal to the real world as far back as possible but can never dispense with it altogether. How far

would Astronomy have got had it been actually confined to passive contemplation of the visual appearance of the sky?

Activity and Passivity

We live, that is are active within our environment, in a selective fashion, giving and taking according to choice and not chance; we live before we perceive. Perception might be purely passive but as a rule we only perceive because we have acted and are going to act. There is a fundamental dualism in all our ordinary thinking on these topics according to whether we adopt the standpoint of activity or passivity. In so far as I am active, myself is where my body is, in fact is my bodily activity. But it is not only my body it is also any instrument I am using. William James gives a good example. When I hold a spade loosely I *feel* the handle, when I hold it tight and dig I *feel* the earth as the blade goes in, I do not merely *feel* the pressure on my hands or the tension in my arm muscles. A man driving a car says, " I just scraped the gate post coming in " he does not say " The car scraped the gate post " unless he is deliberately trying to evade his responsibilities and blame the car. He says " I spoke to Smith in London on the telephone," not " I spoke into the mouthpiece of the telephone and Smith in London heard something corresponding to what I said." We are where we act and we are the activity of that which acts. The external world is what we act on, regarded as separate and distinct from our body and its tools, like the earth, the gate post, and Smith, in the three examples given. It is interesting to notice that the boundary between myself, my body and my tools, on

the one hand and the external world on the other, is a fluctuating one depending chiefly upon the way the causal series that I initiate turns out. While I am digging the earth is felt as external, as the resistance against which I am operating, but when the fruits of the digging appear later on they are appropriated to me and I say " I grew these cabbages." As long as the car runs properly it is part of me but as soon as it breaks down it is repudiated and becomes part of the external world. This is so to some extent even in the case of other persons. If Smith in London is acting as an agent carrying out instructions then I say " I ordered so and so," though Smith did the actual ordering.

When, however, we are passive in sense awareness the division comes in quite a different place. My body is then part of the external world, at least the outside of it is, which I can see and touch like other objects. Myself shrinks up into something inside the body; it is not even the whole body. I say I have a pain in my stomach, but I am not the pain or the stomach, they are outside me. It is here that one form of the distinction between what is public and private in sense awareness comes in. Everything outside my body including the outside of my body is public in the sense that others can perceive it as well as I can. What is happening inside the body like a pain is private because I can perceive it directly and others only indirectly and by inference, as when the doctor prods the place and infers that I have appendicitis. From the point of view of passive awareness what is inside the body, though private, is still external to the mind. The mind or personal activity is reduced to a ghost, or else, last refuge of ignorance, something happening in the cortex of the cerebral hemispheres.

It is at any rate a helpless onlooker gazing at a drama in which it plays no part.

If this is treated as the only view it leads to insuperable difficulties though it would be quite a reasonable one had we been disembodied spirits. Unfortunately, or fortunately, we are embodied spirits. The body has an ambiguous position. As far as I am active it is part of me, as far as I am passive it is part of the external world. Normally we are both active and passive and though we are passive in being aware of anything that is not the consequence of our own activity, we are not wholly passive under ordinary conditions. If we see or feel things, it is because we look and handle and walk about. Our bodies are physical objects in a world of physical objects and our minds are of that world and are activities within it. The more successfully we act the more we extend over and penetrate that world. In any case whether we are successful or not it is peopled with things and persons like ourselves. In so far as we are cognizant of and act upon things outside, our minds are not prisoners within our skulls. Or, if they are prisoners, they are let out on parole except when they sleep. For in sleep, and in disease, our minds do shrink up within the body. They shrink away from the external world and become solitary and confined, absorbed in an internal play of sensations and images. The sensations are shadows of external things and the images shadows of shadows. As long as the shadows are known for what they are and used as symbols they are useful, but they have no business to take the place of the real world.

The passive view of sense experience is not false. It is possible to be absolutely passive. The mind is

then a purely internal activity, it may be literally inside the skull. The world then would be precisely the same whether the mind were there or not. But this is a limiting case. Purely passive contemplation as an episode in life has its place. Something of the sort is necessary as a stage in æsthetic appreciation, and it may be necessary for the development of the highest faculties of mind. Most of life however is activity and preparation for activity and most sense awareness is part of the activity or preparation. We attend to the objects of sense awareness not for what they are themselves but for what they signify The prisoners in Plato's simile of the Den would not have troubled to look at shadows on the wall that had no significance for them, but the shadows of people bringing the prisoners food and drink would be another matter.

It is generally assumed that passive contemplation is attention to all that is actual and nothing else, while the active point of view involves additions to what is actual. Is it not equally likely that passive contemplation involves abstraction from the total situation; abstraction, that is, of the merely present from what is past, future or at a distance which may in its way be actual and is certainly part of the totality of things?

Besides the distinction between the passive point of view and the active another subdivision can be made, that of the person who actually has the experience, the internal view, and that of an onlooker who observes how the experiencer reacts to what the onlooker assumes to be his experience, or the external view. In terms of passive awareness there is a great difference between the external and the internal view. All that the external observer can find are accompanying events related in

some systematic way to what I actually am aware of, simply because I am dependent upon what happens in my body and he is dependent upon what happens in his body. From the point of view of activity the difference is not so great. My activity and your activity operate from different places but they operate in a common world.

The passive view is built up on the geometrical relations of the visual field. Space is what separates things and spatial relations are external. Each thing is where it is inside its spatial boundary and its relations to other things are formal. From the point of view of activity things operate together. Spatio-temporal relations unite as well as separate. Wherever something operates there it is, and to some extent it may be said to operate everywhere. In some places its operations are too dilute to be of importance. In some places its operations practically exclude all others, so that it occupies a volume, though not a strictly defined one.

Returning to our old illustration, when you are awakened by a clap of thunder there is a moment during which it fills the whole apparent universe and you are completely overwhelmed by it and helpless in the face of it. Very soon, however, habits and memories reassert themselves, other experience comes in and yourself and your familiar world grow up round you again The noise is only one ingredient beside others and itself probably fades away. The noise is a sign of some process. It may be a process of no material importance, it may be one which is merely endured passively, it may be one about which some definite action can be taken to avoid it or welcome it. In any case whether an overt act follows or not, some

attitude or other must be taken in regard to it, and a passive attitude is still a kind of act. A small child may be frightened and cry or hide under the bed clothes; an older child may be excited and pleased and look out of the window to see the lightning; an adult will probably get up and shut the windows to keep the rain out, or else turn over and go to sleep. In all these cases except one the noise is considered as a sign of something causally efficacious in a world of causes that may help or hinder the fulfilment of needs and desires. The exception is that of the child enjoying the experience for its own sake. This is an activity but it is an activity that terminates in itself and is not a means to anything else. It is in this sense completely unpractical. It does not necessarily involve cognition and possibly not even perception, it brings us as near as we can be to pure sensation, though of course there may be an undercurrent of cognitive activity. Whatever may incidentally accompany it, such æsthetic contemplation is the enjoyment of present experience for its own sake and a putting aside of all greeds and anxieties and of the whole causal world that helps or thwarts them.

Though æsthetic contemplation will usually be mixed up with other activities there may be only pure enjoyment of present experience for its own sake. It may actually be a contemplation of pure sensation, such as philosophers have supposed to be the origin of cognitive processes but which if it occurs will have nothing to do with cognition, because cognition consists in apprehending what are taken to be signs of things. The child who is frightened cognizes in a primitive way that the thunder clap is a sign of something terrible; the adult who shuts the windows cognizes it as a sign

of rain pouring in; the child who admires the noise and the flashes of lightning does not need to cognize at all; if he does his cognition is incidental, he could still admire what he experiences though it signified nothing.

Perception from the External View

What we cognize as the result of sense perception is matter, according to the traditional view, but what excites the sense organs is energy. That is to say disturbances are what affect us but the disturbances may be small and can reveal the stable conditions giving rise to them. We also assume that the disturbances we introduce are negligible. The energy may be transmitted to the organs by the motions of material things as in hearing or touch, or without the interposition of a continuous series of material movements as in sight. The sense organs, and particularly the distance receptors, are specialized so as to be able to respond to very small quantities of energy of one specific type and to be insensitive to other kinds. In this way they act as signalling mechanisms, and without introducing any appreciable disturbances in the causal world.

Consider first the case of sight from the external point of view[1], that is from the point of view of an onlooker watching the actual percipient. A visible object is a centre from which radiant energy spreads but where the light is reflected the radiation is a function of the stable conditions of the body and not of any important change in it. The radiation is propagated outwards from the object in straight lines

[1] Cf. for this section C. Lloyd Morgan: *Emergent Evolution*: Lecture 8.

through a homogeneous medium; the straight lines constitute one element of order in a process otherwise not necessarily orderly. The introduction of a condensing lens in the path of the rays introduces a fresh element of order, for it brings them to a focus. This is the first thing the eye does to the ingoing physical processes. The next thing the eye does is to transform the radiant energy of light into chemical changes in the retina These changes at any moment possess a definite spatial pattern which is related in a systematic way to the spatial pattern of the objects which are the source of the radiation. So far the visible objects or source of the radiation are actually the source of the energy concerned, but once the retinal changes are started the subsequent bodily processes are maintained by the body's own structure and energy. It is only the last of the extra-bodily events which is strictly the immediate external cause of the perception. The other causal factors are internal processes.

Along the ingoing nervous paths there are probably simultaneous processes at any moment (or over a short period of time) that maintain some systematic correlation of spatial pattern with that of the previous retinal image and therefore with some pattern which may be said to pre-exist in the visible objects. If the object is circular it projects a circular retinal image, at any moment the simultaneous nerve processes resulting are circular or else their spatial pattern is derived from a circle in a definite systematic way. Moving inwards from the receptor organs the pattern gets broken up at each synapse in the nervous system and the processes that emerge will probably have a different pattern though again one that has a systematic relation to what

went in. That is to say where a pattern changes it changes according to rules that ultimately may be known. Sooner or later the ingoing processes from one sense organ or from many converge. The pattern of any one set becomes more and more modified by that of other sets, some of them independent. Finally the outgoing processes have the patterns required for bodily movement and bear no simple relation to the pattern of the ingoing processes which were imposed by external conditions. Still there must be some systematic relationship between what goes in and what comes out and occasionally we can get a glimpse of what it may be as when someone sees an object and reaches out to grasp it. The movement is exactly adjusted to the visible object and it is this very exactness of adjustment that distinguishes genuine perception from illusions and hallucinations. An illusory object is not grasped when the attempt is made. The whole system of processes including the moving constitutes perception of the object and not any part by itself whether in the brain or elsewhere.

Perhaps it is premature to introduce perception and the internal point of view at this stage when we are supposedly taking the external view, but really it cannot be helped. Something is known about what happens in eyes and optic nerves on the one hand and about what happens in motor nerves and muscles on the other. But it is only possible to guess at what happens in between. Inevitably the internal view obtrudes itself to fill in the gap where there is only guess work. For this reason it is necessary to keep the two views in mind all the time, realizing that ultimately they describe the same thing. It is a grave mistake to

use the internal view only to fill in gaps in the information obtained from the external view, for then as soon as the gaps are filled in, as they may be by advancing knowledge, the internal view vanishes. If it did vanish it would make nonsense of the whole story.

This is one reason among others why I object to the widespread notion that the percept, the internal view, is to be correlated or identified with a small selection of those bodily processes which are, in theory at least, discernible from outside but actually are quite unknown. To place the percept among processes in the cerebral hemispheres which nobody knows anything about is merely running away from the problem.

It may be argued, of course, that the cerebral hemispheres are where ingoing nervous processes finally terminate but this is a fallacy based on a misunderstanding of anatomical terms. Nerve fibres terminate in the hemispheres as they do in any nerve ganglion, but nerve impulses or their effects do not terminate unless they are inhibited or otherwise too weak to get through. If ingoing processes are strong and uninhibited they do not terminate in the cerebral hemispheres or anywhere else, but they pass through in the sense that they produce a definite modification of the pattern of outgoing impulses.

It may also be argued, and with some probability, that along all ingoing paths there is some similarity or continuity of pattern. When I look at the full moon circularity or some function of circularity is common to all ingoing processes as far as the cerebral hemispheres, but is not a recognizable component of any outgoing processes. This is at least a plausible theory but it must be remembered that it is only the image on the

retina and the first set of retinal changes that are known to be like a circle and the rest is only guess work. It may be the case that nerve cells situated in a circle in the cerebral cortex are excited in consequence of looking at the full moon, but equally it may not. Nevertheless it is plausible to maintain that the specific difference between looking at the full moon and looking at the new moon does correspond to definite spatio-temporal patterns of excited centres, the pattern in the one case being a function of a circle in the other of a crescent. Even admitting this there is a further consideration. Suppose whenever I see the new moon I turn the money in my pocket as some people do, and when I see the full moon I do not turn it; it is also plausible to say that this action and absence of action are some functions of a crescent and a circle respectively. True it will not be any very obvious or simple function but very likely the spatio-temporal patterns in the cerebral hemispheres will not be obvious simple functions either. This is the only kind of relationship that can be found between what goes on outside and inside the body as seen by a hypothetical observer who could trace out all the details.

All that can be safely maintained is that all causal series in the body whether of ingoing or outgoing processes as they are followed from earlier to later vary in some systematic way, so that each event may be said to be a function of all relevant earlier events. In the whole congeries of events the cerebral hemispheres have a focal position as the main region towards which causal series converge and from which they diverge and where probably nothing goes straight through unaltered. They must be the place where,

more than elsewhere, selection and direction occur; in other words, where the relevance of earlier events is decided. While they are in action they bring about more radical modification of patterns than lower centres do; but there is no reason to suppose that anything absolutely unique happens there. They are head ganglia but otherwise only ganglia.

A perceptual process is not to be treated in isolation. It is a resultant of many past and contemporary events. As long as trivial and relatively isolated acts of perception are considered it is easy to slip into fallacies by making too narrow a selection of events as being the only relevant ones As in the instance of looking at the moon, as long as the sight of it is supposed to evoke no response and nothing particular is supposed to be happening in the body, it is plausible to consider only one set of processes of the immediate past starting at the retina and finishing up (supposedly) in the cerebral hemispheres, and to say that the last of these constitute the percept or are the only physical events that can be correlated with it. As soon as the sight is supposed to be of any interest or the result of any activity or the cause of any activity, such an account is obviously inadequate.

Suppose in turning a corner of a road a man sees a car coming swiftly towards him, he immediately jumps to the side. You may say if you like that he jumps to the side because he perceives a car coming and that what he actually sees is a certain coloured shape getting rapidly larger and slightly altering in form and colour. But is it not equally true and possibly truer to say that what he perceives is an approaching car because he jumps away? It is true that if he comes to

analyse his percept the coloured patch he saw was a very important part of it but it was not the only relevant part. There are all the other accompanying factors in the situation, the noise he hears, the fact that he is walking on a road and has survived previous encounters with cars, and lastly, the fact that he jumps. He might see a car on the films in such a form that the restricted set of visual *sensa* were about the same but he would not jump. Again you may say he does not jump because he perceives a car in a film, but I prefer to say he perceives a car in a film because he does not jump. Of course if he is a nervous man or his encounters with cars have been more nerve-racking than ordinary he may give a start. In that case he momentarily perceives a car on the road; he is in fact hallucinated for a moment. The point at issue could be settled if we knew which comes first the jump or the perception. I should be inclined to say the jump comes first, but then I am prejudiced.

Visual Perception and Optical Processes

At the risk of tiresome repetition I must insist further on some points that seem to me important. The discussion of perception has always centred on vision and quite reasonably because it is the most valuable of the senses, but it is also the most difficult and treacherous to discuss. Unfortunately nearly every one has started off by assuming, quite naïvely that what we actually see is what we ought to see if the image thrown on the retina, according to the laws of geometrical optics, is somehow transferred holus bolus to the cerebral hemispheres and there "impressed upon the mind." (Afterwards, I have no doubt, the "im-

pression" is preserved upon "the tablets of the memory".) This crudely materialist doctrine based upon primitive physiology has been swallowed eagerly by Idealists, Phenomenalists and all. If the facts of direct experience were all against the doctrine, then so much the worse for the facts. There is another fallacy to be noted. It is customary to speak of "mental events" such as seeing something green as though the process of seeing were simple, elementary, atomic and instantaneous. It is true that it is expressed in a word; it seems to happen all in a moment. The simplicity and unity, however, all belong to the object and the contemporary bodily adjustment; there is the green leaf, a movement of head and eyes brings it into view, and that is all; all at least that ordinary language and common sense thinking take account of. It does not follow that the seeing is simple because the object and the external act of looking are simple. In fact, the whole life history of a complex and delicately adjusted organism has gone to produce it. It is a function of a vast system of processes inside and outside the body and is not a single process. I believe that the principal reason why philosophers have got themselves tied up in knots over sense experience is that they have assumed that seeing something green must be momentary, simple and elementary, in spite of evidence to the contrary.

In studying what happens in visual (or any other) sensing or perceiving there are three processes to be distinguished. (1) The external physical processes, such as the durations, intensities and spatial distributions of light; and also the movements and accommodation processes of the eyes and the rest of the body.

Closely connected with these but generally not accurately known are the internal physiological processes. (2) What the experient himself experiences at the moment if his attention is specially directed to that fact to the exclusion of everything else. This may be called deliberate inspection or attention to the actual phenomena. Except in its aim it is like what I have called elsewhere æsthetic contemplation. To attend to the actual phenomena of the moment to the exclusion of everything else is an unusual process, needs an effort of abstraction, is not so easy as it sounds and does not always yield clear-cut unambiguous results.[1] (3) The qualities and relations of material objects that are judged to be present. This judgment is the normal aim of perception.

It is important not to confuse any of these with the judgments we think the percipient ought to make in view of some premature theory as to what is happening in his body. This fallacy is very common and is found even among workers in psychological laboratories, who do not always leave their prejudices outside along with their hats and coats. Three illustrations from the many that could be given should suffice to indicate the pitfalls. Even if the pitfalls are avoided there still remains the problem of how the three processes are related and combined.

The Müller-Lyer phenomenon has been mentioned already (p. 142) What we see is not a resultant compounded of separable unchanging elements according to the laws of geometry ; it is a unitary whole which can be analysed into parts. The parts when isolated

[1] See D Katz, *The World of Colour*, trans 1935, for a systematic treatment on these lines

and taken each in isolation are not the same as when they are together.

Consider next a more complex case recently studied by Dr. Thouless.[1] He points out that when a circular disc is placed obliquely in the field of vision, it is *judged* to be really a circle and is *seen* by inspection as matching an ellipse, but not the ellipse that is projected on the retina according to the laws of optics. The ellipse seen is a compromise between the physical object and its projection on the retina. There are several other cases in which what is seen, the actual phenomenon or visual percept, is intermediate between the physical object, that is judged to be present or cognized, and what ought to be visible from the retinal image according to projective geometry. This kind of phenomenon can be explained on *Gestalt* lines but not by taking account of contemporary visual facts only. Notice, however, that it is still a question of what is seen and not of what is inferred. What is *inferred* is a circle what is *seen* is an ellipse. The seen ellipse is a whole within which the retinal image may be considered as a part, but a part modified by other parts, whatever they may be.

Consider now a still more complex case. Ordinarily our surroundings as seen appear stationary. Movements of eyes, head and body cause relative movements of the whole visual field (apart from what is seen of the body). These movements are not perceived as movements of the visual field, but as bodily movements. Any one however who has been on the sea for some days, specially if the sea was rough and the boat small,

[1] R. H Thouless "Phenomenal Regression to the Real Object." *Brit. Journ Psychol* Vol XXI, p. 339, 1931-32

when he steps ashore sees the whole earth heaving gently round him and has some difficulty in walking steadily. This again is not an inference or a cognition. He infers or cognizes that the earth is steady but he sees it heaving. It is a perfectly definite and genuine visual experience. You can sit and watch it as long as you like, and for the few hours it lasts there is no getting away from it. If the phenomenon is to be explained at all it cannot be explained in terms of visual events only or in terms of contemporary events only, but in terms also of some process following on the events of the previous days when the visual field was actually heaving about in an unusual manner and unusual types of bodily movement were called into play to compensate.

The last case to be considered is more difficult still and perhaps disputable ; it is the perception of depth or distance in the visual field. Admittedly there are many accessory processes such as stereoscopic vision, eye movements, accommodation movements, the relative clearness and size of objects, and so on, to help to give fullness and accuracy to judgments of depth ; and deliberate judgment of depth is explicitly a matter of analysis and inference. Admittedly too perception and inference may often be wrong. Nevertheless I find it impossible to doubt that depth is something directly seen and not merely inferred. We do not open our eyes to see things flat and then find that they arrange themselves in their order of distance away from us as inference and judgment come into play. They are in some sort of order from the beginning even though our judgment of the order may change with further observation and analysis. Sometimes a midge flying close to

appears to be a large bird a long way off. Although at first it appears large and distant and later small and near, the whole time it is seen at some distance or other, just as it is always some shape or colour. If we had never learnt that the retinal image is flat (or flattish) should we ever suppose the immediately apprehended visual field to be flat? We have also learnt it is upside down but we do not profess to see things upside down.

Visual perception or any sort of perception is not to be constructed in any simple way out of the visual data of the moment that can be found by analysis of direct experience, much less from a naïve physiological and physical theory of what those data ought to be. Any act of perception draws upon many sources not all of them to be traced to contemporary stimuli of receptor organs, or even to contemporary sense data. It is primarily a unitary whole within which the analysable elements are not unchanged by analysis. In view of this, certain statements made previously are at best over simplified and a restatement is necessary.

Distinctions were made between (1) the real thing which is causal or which may hurt or benefit, (2) first-order symbols which are experienced in touching and handling it, and (3) second-order symbols which are the non-illusive experiences of it at a distance. These distinctions are a matter of inference and are not to be found initially within the percept as such for it is a single organic whole, though one that is capable of being analysed. The parts when separated out by analysis are themselves single organic wholes.

Let us leave for a moment that deceptive organ the eye and consider the ear which because it tells us less deceives us less. Suppose somebody plays on the piano

a common chord. The unmusical hear a single sound; richer in tone it is true than any one note and not to be identified in pitch with any one note but still a single sound. The trained musician also hears a single sound but one that is capable of analysis and he can say what the notes are that compose it. It is arguable, indeed most probable, that the trained hearer because he can analyse the chord and when he has analysed it does actually hear something different from what the untrained hears, but he does not hear three sounds, he hears one sound.

Now take the physiological aspect and for simplicity let us assume the truth of the Resonance Theory of the ear; namely, that the *cochlea* contains a set of resonators each of which is set vibrating by sounds of a certain pitch The analysis of complex sounds will therefore be performed by the ear itself and each nerve fibre will transmit impulses corresponding to one particular pitch only and the frequency of impulses in the fibre will vary according to the intensity of sound of that pitch. This theory may be wrong, but if it is there must be somewhere or other an analysing mechanism which plays the part of a set of resonators so that it will make very little difference for the present purpose. At any rate let us assume it is true, then we can in theory label fibres or groups of fibres in the auditory nerve with the names of the notes they respond to. Therefore when a chord is heard impulses pass up, let us say, fibres CEG, but clearly neither the process of hearing nor what is heard consists solely of this. It must consist partly of these separate processes in separate fibres of the auditory nerve or there would be no difference between hearing the chord and imagining

it or hearing something else. There must be also a unitary process somewhere where the separate elements are combined so that there is actually one thing experienced not three. Nevertheless it is part of what is experienced that there were three separate processes at one stage in the proceedings.

To be able to analyse a chord into its components some training is necessary. This means that what is perceived depends not only upon the auditory paths by which impulses enter and the impulses in them at the time, but also upon the pre-existing state of excitation of the brain centres. In other words it depends upon previous processes in these and other paths, and more generally the history and present state of the organism.

This case of hearing and analysing a complex sound is a simple and isolated case, something like a mere sensation without much in the way of cognitive complications and even here it appears that the physical correlates of the mental process cannot be solely a limited group of contemporary events in the cerebral hemispheres, even though such a group constitutes the central or key group of events, without which nothing definite would be happening. There is in addition a fringe of other processes past and present which are all relevant ; in so far as the percept, what is perceived, is to be identified with events in the physical world it must be identified with the whole volume of relevant events.

To put the matter in another way, perception is the process by which an already existing state of activity is modified by the entry of fresh elements. The pre-existing state of activity may be of a subdued and indefinite sort and the new elements that enter may be dominant, but they would not be what they are except

for the field on which they enter. The percept is not primarily the entering elements alone, but they and their field and the modified activity that follows all together We can by an effort of abstraction isolate the entering elements from the rest. When we do so they become mere appearance, of value as signs but of no value by themselves.

Of all the elements of human experience that enter into the process of perception the most important and typical are the combined processes of looking and handling from which we derive our notion of a " thing," something that can be seen and handled to some purpose. From the same combined process we derive our notion of ourselves as seeing and handling, and experienced apart from the " thing."

I suggest that a percept consists of (or is to be correlated with) all the causally relevant events, not of any one group however conspicuous, and not merely of all relevant and previous bodily events. Of course there are varying degrees of causal relevance and the whole volume of events will be made up of a focus or centre of maximum relevance with a fringe of less and less relevance as we pass backwards and outwards to earlier and more distant events. Every percept of mine is a new light thrown upon the background of my whole past experience and activity and is what it is as a prelude to further action. Events that are nearly contemporary will be more relevant than those of the distant past and of the contemporary events some are nearer the focus than others. Provided it is understood as a shorthand statement it is legitimate to select as most prominent two sets, namely, those events that are occurring or have been recently occurring in the

object and those that are occurring in the brain of the percipient. These are the two poles of the percept. If you ask *where* is the green colour you see, the only possible answer is first that it is *out there* in the physical world where the object is, but second, that it is *out there as seen from here* where your body is. It is fatal to be frightened out of this view by paradoxes about mirror images and seeing things double.

One reason why people are reluctant to identify mental events with physical events of any sort is that the mind would thereby appear to occupy space in the same sense that things occupy space whereas it seems that in perception space occupies the mind. But the puzzles about the occupancy of space turn upon the fact that there is no simple two-term relation between a body and the space it occupies. It is always a relation of many terms and one of these is the position of the percipient. As long as we think in terms of activity the difficulty disappears. My mind is the activity of my body and where I act I am. As soon as we turn back to the passive view it is hard not to be obsessed again by the simple fallacy of thinking of the mind as a *homunculus* in the brain who picks up the nervous messages as they pass along, but in all other ways is impotent. Then from this we tend to rebound into the opposite fallacy of making the mind the creator of the material world in which it finds itself, so that this world becomes a fantasy the mind projects into the void. We can perhaps avoid both fallacies if we remember that the mind is never merely passive. The mind is the embodied mind (to use Stout's phrase) or it is the activity of the body (to use Aristotle's) or it is the person (to use more popular terminology). Perception

and cognition are the ways, at various levels of synthetic activity in which we react to the surrounding material world. We are competitors in the games and not mere spectators ; speakers as well as listeners.

Perception and Cognition

Generally the distinction between cognition and perception turns upon the amount of synthetic activity that is needed to take in the situation as a whole, for what is apprehended must be a whole contrasted with a background or else it is nothing, nothing but background. It is perfectly legitimate, indeed necessary for complete knowledge to analyse the whole, and among the products of analysis are *sensa*. In the last resort we can analyse down to *minima sensibilia* or *atomic sensa*, as Berkeley pointed out, and can reconstruct complex entities from these. But it must be remembered that the process of analysis is one of abstraction and of idealization, and that when we reconstruct we shall get back something very different unless we realize that all that was removed must go back and nothing else be slipped in surreptitiously, and further that an organic whole is not quite the same as the sum of the separate parts as they were in isolation.

Consider a simple illustration from the field of visual perception (and cognition). Suppose there are two large tables in a room one with an oval top and the other with a round top, as an observer walks about the room the top of each table is responsible for a family (Price's term) of visual sense data of varying shape depending on where the observer may be, according to the old theory of the retinal image. Excluding gymnastic feats such as climbing on the mantelpiece

and looking down vertically on to the tables and assuming the observer occupies normal positions, there should be some *sensa* among the family belonging to the oval table which are round but there cannot very well be any round *sensa* among the family belonging to the round table. To put the matter briefly, the round table should never look round, the oval table may look round from certain positions. Nevertheless everybody coming into the room will unhesitatingly call the round table round and the oval one oval. On a purely phenomenalist interpretation he has no business to do this Mr. Price provides a rather elaborate theory which may intellectually justify the observer's judgment but hardly explains how he comes to make the judgment so easily and quickly.

If you allow the observer tactual and kinæsthetic data to combine with visual data it does not make things easier, because oval and round tactual data are confined to quite small objects. The tactual and kinæsthetic data of the table tops are all spatio-temporal not spatial merely and not round or oval in any simple direct sense. The round table cannot feel round or the oval one feel oval.

If you are going to construct perceptual geometries on logical lines from *sensa* only you must not be surprised if they turn out to be rather remote from the properties of material objects or " things " of common sense. On the other hand if you start with the intention of making your constructs resemble material objects what right have you to possess these notions of material objects ready made? Why is a family of exclusively oval visual data an ingredient of a round table and a family containing round data of an oval

table? The fact surely is that visual data do not directly *constitute* the table top so much as indicate or signify it. The real table top which they signify is what is made, manipulated and used and is not constituted or constructed of *sensa* only. The connection between the family of visual data and the real table is to some extent arbitrary and is certainly empirical, it has to be discovered. The discovery is a synthetic process when it occurs and is not merely direct apprehension, it is cognition rather than perception.

When we can directly experience anything all at once, it is easy to be aware that it is a whole. It is not so easy to realize that a whole can by an effort be constructed[1] from what were originally fragments. Once it is constructed the fragments themselves are altered. For this reason it is specially instructive to consider how we acquire knowledge of the topography of a countryside, because it may be like a simple act of sense awareness or it may be a complex intellectual process. Compare the notions that walking through a stretch of unknown country will give to (A) a scientific explorer, (B) an intelligent savage hunter and (C) the common civilized nincompoop. C is probably as intelligent as B within the range of his interests but he has no interest in the present situation. He does not construct any notion of the country as a whole. The raw material he has to work on is the same as for the others but his experience remains as loose fragments. Left alone he will inevitably lose his way. The savage B has an interest because his life normally depends upon his finding his way home. For this purpose he

[1] Price (p 287, see also p 41) suggests *syngnosis* instead of *construction*, to imply discovery not manufacture.

can make an adequate construction from his experience but that construction will not be much like A's. B's construction is probably simply a summary of recognizable features along his actual route. As he goes along he sees, *a*, *b*, *c*, *d*, etc., in that order and is aware of directions and distances, perhaps consciously by deliberate observation of landmarks, sun or stars, perhaps only half-consciously. All this he can remember in its spatio-temporal order so that he is cognizant of a construct of his whole actual route. B therefore can find his way by repeating his route forwards or backwards. To a limited extent he can take short cuts. If feature *a* can be seen from *d* he can go straight to it omitting *c* and *b*. But if he cannot see it he must as a rule go round the way he came. This is where A's superiority comes in. His construct when fully developed is a map, this is a unitary[1] visual object which synthesizes all the relevant aspects of his experience. It can be seen all at once, or nearly so, it can be memorized, and from it any detail can be extracted as required. It is the essence of the map's function that it is synoptic or syngnostic. B can construct his actual route only and reconstructs by a rather difficult feat of memory and a lengthy enumeration of the details of his route. A's map not only facilitates the linking up of information already obtained but actually provides new information, it enables him to strike out a new path knowing where it will take him.[2] Of

[1] Perhaps not necessarily; but a series of maps needs a key map to combine them.

[2] H St J. B Philby (*The Empty Quarter*, 1933, p. 173) describes the surprise of his Arab guides that he could march south on a compass course marching towards nothing, then turn due west and hit off the main camp that had been left the day before on a north-easterly course.

course a clear view from a hill gives B a synoptic view that does almost everything A's map does and that, given a good visual memory, he can use as a map. There is no doubt either that intelligent savages are quick to grasp the significance of a map when it is explained and can draw rough maps when it is suggested to them. What they lack is not the intelligence nor a synoptic view of a simple sort but simply a knowledge of the methods for accurate construction. For the purpose of this illustration we need not assume that A does more than take compass bearings and pace distances.

The three travellers illustrate stages in the cognitive process. Initially the same experience is available for all. C puts nothing together and it remains mere experience and not cognition. B arrives at the rudiment of cognition, namely a plain summation of the relevant elements of experience in their actual spatio-temporal order. A's is the complete type which constructs a new unit out of the scattered elements of experience, which is much more than a mere summation. Given this new unit the remaining processes by which it is used are analytic. There are always two aspects of any cognitive process, synthetic and analytic. There must be produced or given some sort of central object to have information about. With objects that can be perceived as a whole more or less simultaneously or easily cognized in one simple process the synthesis may pass unnoticed. In fact there may be no synthesis in the sense of a deliberate process of building up separate elements. The unit may be given at a glance almost instantaneously as when we come into a room and " see " it is the dining-room, and that the table is round although we have (presumably) no round visual

sense data and a room for dining in cannot from the nature of the case be a datum of sight.

The savage B when he finds his way home almost certainly uses visual images. How else can he reconstruct his route when only a small fragment is visible at any moment? The function of the images is to act as symbols of what he has seen and is going to see but does not see at the moment. They are the simplest sort of symbol, they symbolize by similarity. They seem to be the only tools he has for the purpose of his cognition and it is upon their richness, steadiness and accuracy that he depends. A may have visual images too but perhaps they are not necessary. Once he has made his map he has a visual object he can look at when he likes. But its function is very like that of B's images. It symbolizes the actual country and does so again by similarity. Still any material object which cannot be entirely sensed all at once and all the time cannot be cognized or even perceived without mental images to fill the gaps of what is sensible but not at the moment sensed.

The transition from perception to cognition introduces or makes explicit another factor. What is perceived is just accepted, at least that is the usual attitude. What is cognized may be affirmed, doubted or denied. Not only is the object different, the mental act may be different. In the meantime it is necessary to say something about mental images.

Images

Suppose, for example, you are supplied with paper and drawing instruments and told to do something easy, to draw a circle two inches in diameter. While

you are doing it you will probably have no mental images, unless it is so easy that your mind wanders. But in any case the mental images will be irrelevant. Because it is easy you do it at once. Your thought processes are sufficiently engaged with what you are actually doing in the way of seeing and manipulating. You may say if you like it is imageless thought. I should prefer to say that action and perception provide all that is needed and images are superfluous, so that the thought is actualized.

Suppose, however, you are asked something harder, to draw a regular octagon with sides of one inch. You cannot, perhaps, act immediately. Perception of paper and instruments and your own actions provide no adequate outlet for your thought processes. In the absence of anything to do you fall back on images, on internal activity instead of external. Whether you solve the problem or not depends upon their adequacy as symbols; it does not depend upon what special kind of image is used. For a problem of this sort some people may use visual images of geometrical figures, some verbal images which may be visual, auditory, or possibly kinæsthetic, some may perhaps use kinæsthetic images of manipulations, there may be other possibilities also, that is to say, processes which on the side of conation correspond to images on the side of perception, "action images." One sort of image may be more adequate than another sort, but they will all be there for the same purpose, to supply a substitute for actual seen figures or actual manipulations of rulers and compasses; they supply, in a word, imaginary solutions of the problem. As soon as a solution seems to be found you start drawing, the images are not

wanted and may vanish only to crop up again if a hitch occurs.

A point that is sometimes overlooked is that images play a part in what is usually considered as perception. Thus anybody entering a room which is strange to him looks all round and gets what is almost indistinguishable from a percept of the whole room. But actually at any moment he only sees a small bit of it. In order to "see" the whole room he has to combine visual images with his percept of the moment. The images here play their simplest role of signifying by resemblance and can at any time be replaced by actual percepts. Visual images, that is to say, are so like visual percepts as to be able to take their place beside them in building up a whole which by courtesy may be called a *percept* but is more truthfully called an object of cognition. This explains the popular confusion, which Price discusses, between data that are *obtained* and those that are only *obtainable*. The gaps available for the latter can always be filled by images.

The room as cognized or deliberately remembered, is not the same as the room as seen at any time or from any one spot. It is not quite the kind of "view" you would get by taking a set of photographs all round from one spot and then piecing them together to give a "panorama." It is a generalized, one might almost say a hypothetical, room as seen from anywhere or from nowhere in particular. It includes fireplace, windows, walls, floor, ceiling, furniture and so on all at once, representing a whole series of views seen in a generalized way. If the room contains a round table, what is cognized or remembered is not any one particular visual oval as seen from one place, but a rather

vaguely defined set of ovals taken as signifying a round top or it may actually be something round. The images are not there merely in virtue of their resemblance to the original percepts, they are there to play the part of symbols and they may symbolize things they do not resemble. Visual images of a chair signify what can be sat on, of the table what can be sat at, of the floor what can be trod on.

I have been assuming, of course, that the room is cognized or remembered as a place to live in where eating, sleeping, working, playing or idling is done. The combination of images which is necessary for memory or is a part of memory symbolizes this. There is another way of looking at it, however, the æsthetic. An artist will probably notice and remember some particular percept or even some particular set of sense data, some particular play of light and shade, some particular combination of colours and forms as seen from some particular place. This is a very peculiar type of cognition, if indeed it is cognition at all. It is a contemplation of sense experiences for their own sake rather than a cognition of objects or things in the causal world.

Leaving æsthetic contemplation out of account, what is cognized or remembered is something that has been constructed like the map of a country though with less effort and with less precision, but it is a whole built up of partial elements. Once it is given the whole can be analysed into simple *sensa*, but it does not follow it was originally constructed out of them for they are themselves the result of analysis. The actual elements that go to the construction of the whole are not *sensa* but partial objects of cognition. The room

is constructed, not of coloured patches, but of walls, windows, floor and so on. Smaller objects of familiar types may be recognized separately and combined into a more complex whole.

It is clear that one cannot draw any hard and fast distinction between the higher grades of perception and the lower grades of cognition. If combining what is originally obtained as separate and filling in gaps with what is merely obtainable constitutes cognition then most of what passes as perception is really cognition. But the final step in the direction of cognition is the use of symbols explicitly known as such, as for instance mental images.

Conclusion

To conclude this discussion I cannot do better than make use of the summary in Chapter IX of Price's book. He distinguishes on the one hand *physical objects*, or as I have called them *real objects*, which are purely causal, characterized by manifesting certain powers in a certain region of space at a certain time. They do not appear but they can be inferred from what appears. Or as I have put it are signified by what appears. On the other hand there is what actually appears as an ingredient of the region physically occupied.[1] The two together constitute a material thing, or complete thing. The objects that appear can be analysed into sense data. These are the atoms out of which perceptual geometries can be constructed, and like physical atoms are theoretical entities. They

[1] Whether the immediate objects of sense experience and physical objects can literally occupy the same space-time or whether they can only occupy corresponding space-times given a rule for correspondence, I am not prepared to argue.

are combined into families, that is to say, into sets of actual or obtainable sense data having certain definable geometrical relations. Phenomenalism is, or ought to be if it was worked out systematically, the assertion that material things are nothing but families of sense data. The old causal theory of sense perception if worked out systematically amounts to saying that nothing exists but physical objects and that sense data are ideas in the mind and no part of the material world, though they are in some obscure way remote effects of physical objects. Against both theories we ought to insist that families of sense data and physical objects both exist and are in some sense coincident in space and time. The sense data are not exclusively the property of the physical objects in the place whence they appear, nor of the percipient mind, nor of the brain or any other part of the percipient body. They require for their description and location both the physical object from which they appear and the embodied mind to which they appear. They are like vectors but are usually spoken of in scalar terms, because it is convenient to leave the percipient out of account.

This view has not the fine simplicity of either phenomenalism or the causal theory, in fact it is extremely complex, but it may be right for all that. The key to the puzzle, if it has a key, lies in the fact that I am aware that my own body is a material object among material objects, both a cause and an effect in the physical world. Sense perception is that special kind of causation which can be treated symbolically and is capable of analysis and synthesis, of being worked up to provide information. Sense data at one end are material, at the other end mental; they function as

symbols. Mental images are mental and symbolic too, their material end is indeterminate (at least I am not prepared to express any views on the subject). If they are not symbolic they are merely obscure bodily processes of unknown origin. As mental images do not in normal minds pretend to any external physical reality their symbolic character is different from that of percepts which represent in a literal sense what is real. Mental images if they represent the real at all are representatives of the past or the future and are the means by which we are to some extent free of the narrow prison of the present moment.

The function of sight (and to a less extent hearing) depends upon the fact that very minute physical processes can operate as signs of large scale processes, and that stable elements in the material world can be apparent and therefore up to a point causal without actually suffering appreciable change. Though visible objects are pushed about by the light that falls on them and is partly reflected the push is quite negligible. Though radiant objects are undergoing violent change, a minute and harmless fragment of the energy liberated is enough to reveal them to us. If it was only what damaged us that produced any response we should live in a world of occasional violent upheavals with long intervening blanks of nonentity. Stable elements and slow small changes would be entirely hidden from us. It is possible for the onlooker to play so small a part in the causal game that he does not disturb the players.

On the other hand when we handle things we become aware that there are such things as rigid solids which are not appreciably altered by handling and are in that respect stable. We can interfere in the causal game and

discover what parts are altered and what parts unaltered. If it were not for this interference the game would not interest us, and we should never distinguish real " things " from mere appearance.

Physical theory on the macroscopic scale is founded on two fundamental assumptions. The first is that there are both stable and unstable ingredients in the world discernible by sight (and other means) without being appreciably altered by that operation. The second is that when we do interfere some things are altered and some unaltered and that we can discriminate between them.

In order to give a complete account of our knowledge of the material world by means of sense experience it is necessary to describe the genesis of the knowledge and also give some logical justification of the results. In either case it seems essential to be able to say what are the data of sense experience. If there were simple original data presented to us by an immediate and infallible intuition, these data should be easy to find. Actually they are difficult to find, it is never quite clear how immediate they are, and there is nothing infallible about them. This makes things difficult for the philosopher but need not lead to complete scepticism.

Psychologists have endeavoured to state what are the actual phenomena of sense experience simply as phenomena taken when and where and how they occur without any ulterior motive, by a process of pure inspection. The process of inspection they use is an unusual and not an easy one ; it does not correspond exactly to the ordinary process of cognizing material objects in daily life or in the practice of the physical sciences. The data they find are like many of the data

of ordinary cognitive processes but do not include them all. They are abstract like the *sensa* of the analytical method but not so fictitious.

The material world within which we suppose we live is a construction based upon activity and experience. The validity of our conclusions rests upon the coherence of the constructions and their congruence one with another. The appeal to what is immediate in sense experience may be indirect and is most definite and conclusive when it is negative. A construction will be upheld and developed as long as it leads to nothing incongruous with experience. The incongruity can be discovered if it is glaring enough and can be recognized as immediate and unescapable even if it is not easy to say in positive terms what really is present. In scientific investigation the appeal to immediate experience is made as far as possible in a simplified way, it is formalized and hedged about with safeguards against misinterpretation. In the last resort it tends to take the form of manipulating an instrument according to a carefully learnt routine and reading off the position of a pointer on a scale. The simplified and formalized experiences of scientific observation are just those that can best be fitted into a scheme of perceptual geometry and based upon analysis into atomic *sensa*.

CHAPTER VIII

EMOTION AND THOUGHT

THE easiest way of approaching the study of mind seems to be from the cognitive aspect, and in modern times up till the most recent years that is the way in which the approach has usually been made. It is the easiest because it can keep to the level of conscious processes, discussion is concerned with the objects of which we are aware But as long as discussion turns solely on the cognitive aspect, the mind tends to be considered as passive, static and solitary. Moreover the mere fact of consciousness, which does not in itself reveal anything as to the nature of mind, becomes too prominent. This aspect must be corrected by another point of view according to which mind is conceived as active, dynamic and social, i e., the conative aspects. This approach is much more difficult and indirect because one cannot appeal throughout to what are actual or possible objects of consciousness. Either aspect, cognitive or conative, is dangerously abstract, if any real separation is assumed. Perhaps we can get over the difficulty to some extent if we consider the process of thinking, as distinct from the process of apprehension of the immediate environment. Thinking is a conative activity but it is one directed towards actual objects of consciousness that are open to inspection ; or some at least are open to inspection. We may not be able to say why we think of this rather than that but we can say what we think about and to

some extent how we think about it, because these are differences belonging to the objects of thought and to the consequences of thought.

Thinking is a substitute for action and therefore it may be unaccompanied by any outward action. Thinking is also interruption of routine, of stable concatenations of stimulus and response, and so can be seen expressed in certain special forms of action. Something like it can be seen in the play of young animals. The lamb just frisks, that is as far as its thought can go, the kitten does better and wages mimic battles and conducts mimic pursuits. Here we see clearly the beginning of that symbolism which is the essential character of the higher forms of thought. But the kitten merely performs acts that are like pursuing and killing. A child can go farther and may symbolize his acts by means of arbitrary symbols as in language and he can do without any overt act at all by means of symbolic processes that do not visibly escape the confines of his body, that is by mental images or perhaps even without them. The symbols if they are overt bodily acts or images, are objects of consciousness and capable of direct study in a way that mental acts as such and all unconscious processes cannot be studied.

Language is the symbolic system by means of which the thinking processes of men are carried on and communicated. Therefore one would have thought the study of the character and function of language would occupy the attention of psychologists who are interested in the highest mental processes, though most of them perhaps are not interested.

We do not think by and for ourselves alone, unless

we are qualifying for the lunatic asylum. Thoughts can be communicated, so that the thinking processes of different individuals can be co-ordinated. Now communication is based upon *imitative action,* or, the same thing under a different aspect, *sympathetic emotion.* Language is primarily something that helps different people to co-operate by harmonizing feeling and action. The earliest forms and functions of human language are to be seen in the dances, songs and ceremonies of primitive races, which still survive in the modern world in children's singing games and in a less pleasing form in military ceremonial. The use of language for the communication of "ideas" and for supplying information about matters of fact is a very late and sophisticated development.

It is unfortunately necessary to preface a discussion of language and thought with some consideration of emotion and allied topics. This is a discussion I undertake with great reluctance on account of its difficulty and obscurity.

Emotion

The division of mental processes into cognitive and conative is a fairly obvious one and appears to receive support from the physiological distinction of ingoing and outgoing nervous processes and of stimulus and response. I say appears to receive support because a moment's reflection shows that any process which can properly be called mental, that concerns the *psyche,* involves both stimuli and responses and both ingoing and outgoing processes, in fact the whole organism. The two kinds of bodily process are no guide to the proper way of considering the *psyche.* Therefore

there need be no difficulty about recognizing a third aspect, intermediate between cognition and conation, that was suggested by Kant, and that may be called *feeling-tone*. Some psychologists have considered *pleasure* and *displeasure* (not *pain* which is a term that ought to be restricted to a special type of sensation) to be the only ingredients of feeling-tone, but others are prepared to admit further ingredients that add colour to this plain black and white. The other ingredients are what may be called the affective aspect of the emotions, as well as excitement and repose, strain and relaxation. In this sphere it is almost impossible to find any clear basis of classification. The meanings of terms slide into one another in a hopeless way. There are no boundaries anywhere, so that anybody can make the words mean anything he likes. Still one has to try to say something about it.

It seems clear that pleasure or displeasure may belong to a situation where we are as nearly as possible purely receptive and passive. Pleasure also belongs to any condition of free unimpeded activity (as Aristotle said) without being definitely connected with any element of sensation. Correspondingly displeasure accompanies impeded or thwarted activity.

Pleasure and displeasure are the most central, the most private and in a sense the least material of all the aspects of mental life. But if I try to introspect the result is disappointing. I can find pleasant and unpleasant sensations. I can sort them out to some extent as to their degree of pleasantness and examine them in combination and separately.[1] This is all nothing but *inspection* of the qualities of sensations. I

[1] Cf Wohlgemuth: *Pleasure—Unpleasure*, 1919.

can judge the smell of ammonia as unpleasant when strong, pleasant when weak enough. The pleasantness or unpleasantness are just qualities of the smell like its faintness or strength. This cannot be the whole story, however; being pleased or displeased is not simply having pleasant or unpleasant sensations though they may be a large part of the cause. If there is such a thing as introspection at all, it should be just this, the tone of consciousness which is introspectible. If introspection is valid at all it does seem to me to indicate that though sensations are just pleasant or unpleasant the tone of consciousness, or feeling attitude, is much more variegated. The variegations are in fact the affective elements of the emotions. More than that I do not profess to be able to say and I do not believe that it provides any important information. I can be aware *that* I feel pleased but it is a bare unrelated fact. I have no intuition as to what pleasure is in itself or how it is related to any ordinary object of thought. If we are going to find out anything about pleasure or displeasure we must turn to observe the pleasure and displeasure of others. This may be difficult but it is obviously not impossible.

If the subject of pleasure is difficult that of emotions is harder still. No two psychologists can be got to agree even as to what names to give them or how many different kinds there may be. It may be doubted if the professional psychologist usually knows more than the plain man, who, whatever his occupation, has to deal with his own and other peoples' emotions every day. If he is capable of learning anything by experience at all he has as good opportunities as most psychologists. The psychiatrist perhaps will do better. When

the mind disintegrates the emotions come to the top.

In dealing with emotion I shall for the most part follow McCurdy whose account is the best I have come across.[1] He sums the matter up in a metaphor; "it is the boiling over of heated instinct that provides the push of emotion." If an appetite or instinctive drive of any kind has full play and runs its course to its natural conclusion, there is nothing to call emotion. If it is completely obliterated by an opposed impulse which itself has free play there is no emotion. Partial obstruction or incomplete development from any cause makes "the heated instinct boil over" and then there is emotion. For this reason strong emotion is often visible externally as over-action or even mal-adjustment to the situation. Hence comes the familiar opposition of emotion to reason or intellect, for reason implies adequate adjustment. This also explains the use of the word "passion" for the agent feels as though pushed by something not himself though "passion" and "emotion" are not generally quite synonymous. From the internal view, apart from the obvious bodily or organic sensations emotion gives a peculiar flavour to consciousness. Therefore we speak of "feelings" as almost the same as emotions. This aspect is the "affect" or "affective tone."

According to this account the man who runs away from danger is less frightened than the man who stays. Put baldly in this way it sounds paradoxical and even ridiculous; but when it is stated carefully with the necessary qualifications I think its truth will be

[1] J T McCurdy: *The Psychology of Emotion*, 1925, and *Common Principles in Psychology and Physiology*, 1930.

admitted. Fear is essentially the product of a dangerous situation we cannot immediately cope with. Inability to cope with it may be physical or intellectual; we may be too weak or too ignorant. The pedestrian crossing the road in the face of traffic will tend to be afraid if he *cannot* move fast enough or does not *know* which way to move. If he is both swift and cunning he will not be afraid, in fact he will enjoy his performance and feel contempt for the traffic. There is a possible complication, he may be able to skip out of the way and know how he ought to do it but be too proud to hurry. In that case he will almost certainly feel fear whatever his overt acts may be (assuming he remains alive). In other words, some alien motive and its accompanying emotions may enter in to prevent straightforward response to the situation.

In any situation likely to produce fear the possible actions will be either some form of advance towards the dangerous object or retreat from it, leaving out for the present the alternative of doing nothing. Of course there are wide possibilities within each class. A man may run in various directions at various speeds for various distances; he may run and hide or go on running. He may actually oscillate between advance and retreat. In spite of all complications, fear is essentially that which urges us to retreat. To begin with the greatness of the fear varies with the extent to which one refrains from retreating or is prevented from retreating. Once the fear has begun it tends to continue however fast and far its victim runs; that is the characteristic over-action of emotion. In the end, however, running away allays fear by removing the object of fear, but advance

towards the object also may allay fear by calling in a rival emotion.

Just as the emotion of fear urges us to retreat, there should be a directly opposed emotion urging us to advance. This may be anger in some cases but not necessarily so. The mountaineer who tackles a dangerous climb is not angry with the mountain or with anything else. Aristotle remarked that in his day there was no name for the emotion opposed to fear and curiously enough the word seems to be lacking still.[1] It is notorious that the most effective way to abolish fear is actually to go forward to meet the danger whatever it is. Once fear has set in, to go back even for the best of reasons, is to give the emotion its opportunity. Merely acting as though we were under the influence of an emotion is capable of producing the emotion. Numbers of children make the valuable discovery that if they turn down the corners of their mouths and make a noise like crying, real grief very soon follows. Emotion implies conflict, hesitation, or some lack of adjustment or foresight. It is never far away because there is always a host of impulses ready, as it were, to leap out the moment they are unleashed. Few situations are so simple and so adequately grasped that there is no kind of doubt or hesitation as to what to do and a single appropriate impulse runs clear and unimpeded to its conclusion. But if such situations occur I think it will be admitted that they will not involve any emotion. It may be noticed in parenthesis that on this view there is a very close connection between emotion and thought; so that one might say, no emotion no thought. It is because human emotion

[1] J L. Stocks has suggested the term "cheer" to fill the gap.

is saturated with thought, that its consequences may be so devastating.

While some degree of emotion is common to all ordinary activity and is part and parcel of our lives, extreme emotional states are rare and border on the pathological. They are the result of something unusual in the external situation which is beyond our powers to deal with or of unusual feebleness in our powers of coping with ordinary situations.

Many of the external expressions of emotion are of the nature of by-products and have no definite relevance to the external situation, they are simply a way of blowing off steam. The very characteristic human actions of laughing and crying are good examples. Neither is in any way functional. The kind of person who is lavish in the display of these extras and is commonly called emotional is often deficient in emotion in the proper sense. That is to say so much energy is devoted to non-functional activity that little is left for functional activity.

As has been mentioned there is no stability about the attempts that have been made to classify emotions, and nothing more will be said on the matter beyond noticing in passing that many of the emotions naturally go in pairs of opposites, one corresponding as a rule to advance, the other to retreat. For instance, pride makes a man "pushing" and humility "retiring" and so on. In so far as there exists a positive and a negative there should be an intermediate or zero state corresponding to no emotion and no action. This is almost certainly so but the zero position is very unstable if not painful and is a sophisticated rather than a primitive state of affairs.

Except for the negative emotion of fear (and of disgust, if it is an emotion) which may be aroused by any sort of object or by none, the objects of emotions are persons rather than things. If they are things they are personified things or are associated with persons. In fact this is the primary distinction between persons and things that we approach persons emotionally and things unemotionally. Fear may be aroused by a situation apprehended as dangerous or by what is unfamiliar and unknown therefore not properly cognized at all. It is the last that is most terrifying, for obvious reasons. Apart from fear, things are cognized as useful, harmful or indifferent, pleasant or unpleasant and so on. Behaviour towards them is uncomplicated, unrestrained, and cognition very often reasonably adequate. Cognition of persons is always incomplete, often quite inadequate, and behaviour towards them complex, the result of mixed impulses. The life of a really solitary man would be simple and free of emotion (apart from fear). It might be dull, but if he had few pleasures he would have few pains (other than hunger or indigestion). What makes a solitary life unbearable for most men is thinking about the pleasant companions they have not got. Had they (to assume what is actually impossible) never known the company of their fellows they would never miss it. At any rate, man is a social animal. He does not like being parted from his fellows and wishes to co-operate with them. But his most difficult task is to adjust himself to them and hence his emotions. Amid all these difficulties there is one important compensation. Emotions spread from one to another by sympathy or, to put it the other way round, acts are done

imitatively, so that social life, though difficult, is possible.[1]

It is curious that psychologists do not as a rule take any interest or see any difficulties in sympathetic emotion, at least they do not discuss it. The Behaviourist if he deigns to notice such a thing dismisses it airily as a conditioned reflex, but whatever it may be it cannot be that because there is no conditioning.

Imitation is a very primitive kind of act, you find it quite low down in the animal kingdom wherever animals behave as a herd. The shoaling fish turns when it sees others turn, the young rabbit runs to its burrow when it sees others run, the lamb skips when it sees others skip, the baby smiles when it sees its mother smile. Notice that the acts of turning, running, skipping and smiling in no way resemble the sight of others turning, running, skipping and smiling. The association of stimuli necessary to produce a conditioned response can only be obtained if the fish, rabbit, lamb and baby have all been watching their own performances in mirrors. If the baby has smiled at some private pleasure and seen himself in the mirror then the sight of a smile on somebody else's face may become a conditioned stimulus to produce a smile on his own. It is hard to believe that this is the usual course of events even with babies who have access to mirrors and still harder to believe in the case of fish. Leaving mirrors out of account, we might suppose that the baby has smiled at his own pleasure and that actually his pleasures are largely a consequence of his mother's

[1] What I have called sympathetic emotion is very closely related to the "Herd Instinct," but I would rather avoid this term. The herd is a consequence of the working of a large number of instincts in a collection of individuals; it is not a psychological entity nor is there one instinct only.

presence and that he has seen her smiling when he was pleased himself. From this one can concoct some sort of an account, but it is still extremely unplausible, because it does not explain why the sight of a smile on his mother's face, or even on somebody else's, should be a specific stimulus to smiling himself. In any case it leaves the fish, rabbit and lamb unaccounted for.

There is another case still more damaging to the conditioned reflex theory. The cry of terror instantly produces fear in all who hear it. An adult may be able to suppress the spontaneous fear naturally produced but a child is easily thrown into a panic by it. In fact, as everybody knows children and babies are easily frightened by any sign of fear on the part of those they look to for protection, as indeed are dogs and horses. This sympathetic reaction is not acquired by conditioning or learning, in fact conditioning or learning tends rather to abolish useless manifestations of fear.

Those who insist on talking of reflexes in this connection can say that imitation or sympathetic behaviour is an unconditioned reflex without much fear of contradiction. To say it is a conditioned reflex is just nonsense. The safest course is to admit as a fact without explanation that man is naturally or innately imitative or that his emotions tend to be aroused sympathetically by the display of emotion by others. Anyone who tries to explain the fact must realize clearly that acting in a particular way bears no resemblance to seeing others act in that way or hearing them utter sounds.

If social relations are admitted to be founded on

sympathetic emotion, it must also be admitted that they are greatly complicated by anti-pathetic emotion. This seems to be a fact equally fundamental and equally hard to explain.

Emotion has two aspects, one that of affective tone of which only the experient is directly aware, and the other its external expression in speech and action of which the external observer is most fully aware. Our experience of emotional affective tone is accompanied by organic sensations, for instance the "sinking feeling" accompanying fear. If these were taken away it is not easy to say what would be left. Certainly nothing very definite and nothing very informative. In order to discover anything about emotion it is little use trying to introspect; the only feasible method is to observe the expression of emotion in action in ourselves and specially in others. Sympathetic emotion provides a reasonably good guide for the identification of emotion in ourselves and others.

Both the affective aspect of emotion and its external expression are symptoms; symptoms of an underlying instinct, appetite, desire or impulse of some kind at work below the surface. These impulses are hypothetical, perhaps mythical entitles, but we cannot do without them, however various are the thoughts they inspire in different psychologists. Among all the differences of opinion there is one point of agreement, that the fundamental impulses in man are many and in themselves disorderly. If they all had free play the result would be not merely chaos but paralysis. This is a simple consequence of the fact that the organs of action are many and can operate in many different ways, that they are the termini, in Sherrington's

phrase, of final common paths. Even an oyster can do three different things and man is more complex than an oyster. Some kind of control is necessary. Again it is universally agreed that the controlling factor is a unity, but after this there is less agreement. It has been called Will, Ego, Intelligence and so on, though always in the singular.

It is the cognitive aspect of mental life that most clearly provides unity. The field of consciousness is one single field. The very diversity and plurality of the senses and of the objects of sense within consciousness only help to emphasize the fact. There may be a surrounding fringe of processes below the threshold of consciousness but it is a fringe like the circumference of a circle emphasizing the fact that there is one centre.

Intelligence

The lowest and least co-ordinated types of impulsive process need for their development two factors (1) something of the nature of a cognitive process and (2) a suitable internal state of the organism. The development of the activity of feeding needs the apprehension of food as present or possibly obtainable by suitable action and therefore present in imagination, if only vaguely. There must also be the bodily condition of hunger; at least, on the negative side there is always a state of repletion after the attainment of which feeding stops however much food is available. Obviously feeding is incompatible with many other activities. A dog has to choose whether to eat his bone or chase a cat, he cannot do both. He may want to do both and both objects may be present together within his cognitive field. You may say that what the dog

does depends simply upon the relative strength of the two impulses, the feeding and the cat-hunting impulse. But such a statement merely introduces a piece of gratuitous mythology. There is no method of measuring the " strength " of an impulse apart from seeing what the dog actually does. It is better to deal with the matter in cognitive terms, even if that means abandoning the attempt to discuss dogs and confining ourselves to human beings. For the moment I shall treat the dog as though he was human simply because what I have to say would sound rude as applied to man but quite suitable for a dog.

The dog looks at the bone and smells it and is aware of it as something edible. Organic sensations from his digestive organs and other less definite internal processes emphasize this aspect of the bone. Then he looks at the cat and is aware of something to be pursued. This aspect of the cat varies with the cat's appearance. If it is far off and slinking away this aspect is not reinforced. If the cat is coming nearer and behaving in an insulting manner then it is reinforced. Suppose the dog actually eats the bone and leaves the cat unmolested, then the bone as edible object occupies the centre of attention and the cat sinks into the perceptual background as indifferent as a stick or stone. Similarly, *mutatis mutandis*, if he leaves the bone and chases the cat. We are not justified in saying either that *because* he decides to eat the bone it becomes the central object or that *because* it becomes the central object of cognition he decides to eat it. To put in a *because* either way is to make an improper separation of the cognitive and conative aspects, of thinking and willing.

In all this there is nothing to be called intelligence or reason, though there is a cognitive process. If the dog were intelligent the further step he could take would be to argue the matter out with himself. Not content to apprehend only the actual momentary state of affairs he would imagine possible developments. He might say, " Without regular meals I cannot preserve my health : I must eat." Then he might say, " But what is life without honour ? If I don't chase the cat I shall never again be able to hold my head up among my fellows. I will chase the cat first and then come back to the bone." Then again, " Suppose somebody steals the bone while I am after the cat ? Anyway, the last time I chased a cat my nose was sore for a week afterwards "—and so he may go on, the native hue of resolution becoming sicklied o'er with the pale cast of thought.

At the lower level the cognitive process deals only with the situation before it, coloured and differentiated by old habits of action so that some elements appear desirable, some hateful, and so on. At the higher level, where intelligence operates, the process is extended to deal with possible developments and still further with principles of action. That is done by means of images or other signs, which in the dog's case I have supposed to be verbal, though we normally assume a dog has no verbal symbols at his disposal. The difference between the two levels will ultimately be reflected in a greater elasticity, complexity and greater success in action. At least we human beings try to justify ourselves by asserting that our success is greater.

Intelligence is not merely negative in function but is positive also. The result of its operation is excitation

as well as inhibition, release of impulses as well as their suppression. If we can foresee all possible developments of a situation we provide scope for all appropriate impulses in their order and for the elimination of all inappropriate ones.

Intelligence is often pictured as something which looks on helplessly while instincts and appetites move to action and which has to be content to " rationalize " or invent excuses for what is done This picture describes something that often happens but which is pathological however often it happens. An unresolved conflict between incompatible impulses results in a sham unification, which is always a lie, however much it deceives the " rationalizer " himself. A trivial instance of what may happen in post-hypnotic suggestion will explain what is meant. It is suggested to the subject that at a certain time he will do something quite irrelevant to his current occupation. Thus he may be sitting talking to his friends and acting on the suggestion suddenly get up and turn a picture round to face the wall. When asked why he did it he hesitates and then makes a lame excuse : he disliked the picture or he wanted to see if there was anything on the back of the canvas. These are " rationalizations " but they are also lies. If he was truthful he would say, " I don't know ; it was just an impulse I cannot explain." He makes up the lie simply to avoid admitting he has impulses he cannot explain. To admit it would be to admit some degree of mental disintegration, which is exactly what has happened.

In the properly integrated mind (which is probably rare) the various appetites, instincts and what not, come in and go out as they are needed to keep up the

unified play of thought and action we call the person. They are like actors who wait their cues and know their exits, and play the parts assigned to them. In this way the play goes forward. If an actor is on the stage at the wrong time only desperate gagging can preserve a semblance of dramatic unity and movement.

So far intelligent behaviour has been considered as behaviour in accordance with a foreseen end, that can on that account be described in rational terms. A word of warning is perhaps needed at this point. Because behaviour is described as intelligent or rational that does not imply that in any given situation there is one unique mode of behaviour to be accounted rational and all others irrational. There may always be a number of different possible ends and a number of different means of attaining any one end. Reason in this sense is, like a chart, a necessary aid to navigation and not a talisman to preserve the owner from shipwreck. All that is meant is that intelligent or rational behaviour is purposive in the narrow sense of being known to be adapted to a known purpose, and not as at the instinctive level merely happening to be well adapted to what may be supposed to be an end blindly pursued.

This clearly does not take matters far enough. The hierarchy of human functions does not stop at this level, the level of the *Ego* in Freud's scheme, or the *Spirited Element* in Plato's, because purposes are still many and different. It is not enough to have *a* purpose. It may be clearly conceived, persistently pursued and brought to a successful end but it may be condemned as trivial, destructive of more important purposes or positively bad. That is why Plato introduced *nous* as a third factor and that is also why

Aristotle was in two minds about the status of *nous*. For *nous* is not intelligence or reason in the usual present-day sense, that I have been using. It is rather, in Kantian terms, the principle capable of conceiving the Moral Law and acting in accordance with it—and often making a hash of the business, if Freud is to be believed. The conception of *nous* is ethical as concerned with Good and Evil, Right and Wrong and is not merely teleological.

At this point there may be an irreconcilable dualism as Plato thought. Perhaps no approach on naturalistic lines can even grasp the complete nature of mind and *Nous* must be discussed in quite other terms. If I were writing a treatise on Ethics I should have to face this question. As I have said before, I can put it aside at present, and merely repeat also that I have not said there *is* a dualism but only that there *may* be.

Mind as cognitive appears to be one and indivisible, and the function of cognition is to make and preserve that contact with the external world which preserves its unity. Mind as conative is based on a plurality which needs integrating or harmonizing. From this arises the tendency to see mental conflict as a conflict between intelligence, reason or thought (supposed to be purely cognitive) on the one hand, and emotion, passion or instinct (supposed to be purely conative) on the other. Actually every complete mental process has both aspects. The correct method of stating the opposition is not between thought and emotion but between integration at a higher level and at a lower level, or between genuine and sham integration, or in the worst case, frank disintegration. When we say in condemnation of a man's acts that they are due to

emotion and not reason, what we ought to say is that they are due to low grade reasoning and violent emotion, in a case where high grade reasoning and moderate emotion was called for to deal adequately with the situation. High grade reasoning is difficult, rather slow, and may involve intervals of painful uncertainty; by dispensing with it action becomes quick and easy, and gives greater satisfaction, for the time being.

What has been said does not really provide a definition of intelligence and it may be well just to mention an apparently simple definition designed to avoid the complications mentioned.

Intelligence has been defined as the capacity to react appropriately to the environment, but when that has been said it is necessary to explain what is meant by environment.[1] If we hear a drowning man cry for help, and we respond by putting our fingers in our ears and turning our backs on him, that is an appropriate response to the environment in the sense that it effectively disposes of unpleasant sensations. But it only deals with the immediate environment of the moment and not with the remote environment, which includes the approval and disapproval of our fellows, as we shall discover to our cost when questions are asked at the inquest. We still have to decide how remotely to draw the boundaries of the environment. The behaviour of Socrates was not entirely appropriate to his contemporary Athenian environment, yet he would have claimed that it was for him the only really appropriate behaviour. Any one of the Early Christian

[1] I believe Herbert Spencer is responsible for this definition He was probably quite aware of its implications

martyrs would have put the matter quite simply—behaviour that is appropriate to the Kingdom of God is often not appropriate to the Roman Empire. It is interesting to see that this innocent, and on the whole excellent, Behaviourist definition of intelligence leads at once into the sphere of Ethics and Religion, to the grave scandal of all good Behaviourists.

These complications are not going to be avoided by making a distinction between pure reason and practical reason for that merely creates two problems in place of one. Nor is the question to be shelved by the ingenuous device of certain psychologists who say that intelligence is what is evaluated by " intelligence tests," because it still remains for them to explain on what principles they select the special tests they use from the infinite variety of possible tests ; why for instance they do not set their subjects to run a hurdle race, but do set them to work out arithmetical problems, or verbal problems depending on the correct use of correlative terms.

The Behaviourists who say that intelligence is successful or appropriate response to environment are obviously thinking of rats running in mazes and not of fully developed human beings. They are assuming that the rat's environment is the immediate environment from minute to minute. In their experiments they get over the complications due to the effects of the remote and immediate past by using interbred rats of racially pure lines all brought up together and all of the same age. Thus they produce a highly abstract and simplified environment which can be accurately defined, it is in fact simply the maze and the bait at the end of it. It is also assumed that the animal is

ruled by one motive only—to get through the maze and reach the bait. If the rat sits down in the middle of the maze and washes itself, that is put down as a spoilt experiment, but it may be the rat's attempt to display a higher level of intelligence than the experimenter has bargained for.

If this definition of intelligence is to be applied to levels beyond the very lowest it becomes necessary to allow for extensions in the environment and developments in the motives or impulses at work. In fact the very word motive is only a metaphor at the level of crude impulses as it implies a developed cognitive process and a foreseen or imagined end. The function of thought is above all this process of extending the environment beyond the immediate ; it is the capacity to look forwards and backwards which has traditionally been held to distinguish man from the animals. This implies two things, a temporary detachment from immediate reality to get a fuller grasp of reality later and a medium for the thought process to work in.

Thought and Symbolism

Before dealing with this question of the medium for the thought process it is necessary to introduce a distinction between thought and judgment. All thought processes aim at terminating in judgments. They may be formulated as practical judgments, a decision to do so and so (and doing it) or hypothetically to do so and so if such and such happens (and then doing it), or simply as theoretical judgments, that so and so is the case or that if so and so is the case, such and such is also. Judgments however are frequently, too frequently, the end result not of thought but of

habit. Some thought processes never terminate successfully in judgment.

Most of the experimental work that has been done of recent years on skill, memory, and intelligence (by means of mental tests) deals essentially with judgment rather than thinking. Mental tests or intelligence tests for example test directly accuracy and rapidity of judgment in certain types of situation. Incidentally they throw light on the thinking process but only incidentally.

Suppose the question is asked—what is the value of nineteen squared? Somebody who has learnt square numbers off by heart can answer without hesitation 361 and answer without thought. Though thought may have been needed earlier when the numbers were memorized it is not needed to give the answer, which may almost be called a "conditioned reflex." The answer may also be produced by what may be called the physical method of making a row of nineteen dots and then another, and another until there are nineteen rows in all, and then counting them all up. This method can scarcely be dignified by the name of thought but it results in the same judgment in the end. In between these two methods are the ordinary methods of arithmetic which do involve thought. The arithmetical methods by means of symbols provide short cuts which avoid the labours of the physical method and can do things of which the physical method is incapable. The symbols that are used may be actual marks made on paper, they may involve overt action and perception of objects. I may actually write down $-19^2=(20-1)^2=400-40+1=361$—and then read off the answer; or—$19^2=20\times18+1$. Or I may do the

sum " in my head." This is not quite so easy for those who are not good at arithmetic, like myself, but I believe it can be done. There are various ways of doing it. You may visualize the signs as though written on paper. You may use verbal signs and say " Nineteen squared, that is twenty minus one all squared "—and so on. You may not actually say any words at all or even whisper them, you may have visual images of the words as written, or auditory images of them as spoken or possibly kinæsthetic images. If anybody says that he can do the sum " in his head " without images, verbal or otherwise, his statement must be accepted. But I refuse to believe he does it without symbols of some sort and must conclude that the symbols he uses, whatever their nature, are not present to him as objects of consciousness, and yet can be manipulated according to rules.

Another thing I refuse to believe is that there is any fundamental difference in the thought process whether the symbols are physical objects like written signs and spoken words or are mental images, or neither of these. The essential point about thinking is not that it happens inside your head instead of outside but that it consists in formulating and manipulating symbols. It may be handier to have the symbols inside your head or it may not, it depends entirely on circumstances.

It might be argued that an external symbol must always be preceded by an internal symbol ; that is to say I cannot write the digits 19 until I have had a corresponding mental image. It seems impossible to believe this, unless the assistance of unconscious images is assumed. Further if it were true, then those mental images which are followed by corresponding actions or

objects would be functionless as symbols but would be quasi-causes. Those that are not followed by external symbols would function as symbols but not be causes. There would be a very complex distinction between two types of image. I think the argument can be set aside as being very unplausible.

There are certain important features of arithmetical symbolism to be noticed. (1) The individual symbols are entirely arbitrary, except perhaps for those for zero and unity which do to some extent symbolize by similarity. The advantages gained by arbitrary symbolism are easily seen by comparing the Arabic notation with the Roman. The clumsiness of this latter is the result of trying to use symbolism by similarity. (2) Once the meaning of each arbitrary symbol has been assigned its meaning remains unambiguous in all possible combinations. (3) There is a limited, in fact quite small, number of symbols by combining which according to rule any number whatsoever can be symbolized (4) There are definite rules for the manipulation of the symbols such that any calculation however long and complicated that is done in accordance with them will give at the end the correct answer. These rules do not depend upon the particular arbitrary sign selected but are rules for handling any sign of a certain type selected for certain types of significate. If the rules have been learnt the manipulation of the signs may not strictly speaking need thought. The signs are then what Stout has called " substitute-signs " and are essentially a labour-saving device, or rather a thought-saving device.

This is satisfactory enough for mathematics ; when we turn to other forms of symbolism things are not so

simple, in fact characters (2) (3) and (4) are entirely lacking. Mental images, other than verbal, symbolize by similarity. Visual images operating in this way are very useful for filling in gaps in the perception of objects, as has been mentioned previously, but otherwise are extremely defective. If I call up a visual image of a dog it has to be a dog of some special size, shape, colour and hairiness. It is probably simply a mixture of several particular dogs. The image has not got the complete generality and abstractness of an arbitrary symbol like the word "dog." At the same time it lacks the concreteness and inexhaustible detail of reality. It makes the worst of both worlds, too concrete for manipulation in thought, too vague for reality. That is where the arbitrary and general signs of language come in. With language thought becomes general and therefore free and with unlimited possibilities.

So far so good, but there is a fly in the ointment, in fact two, of contrasting sorts. First the freedom of thought is not complete, it is still tied down by the limitations of the symbols and is perhaps perverted by them. For no symbol is perfect; it may err by excess in that it conveys more than it ought and by defect in that it conveys less. Secondly, as far as thought is free the freedom can be misused and thinking degenerate to mere fantasy.

The fundamental principle of language symbolism was well expressed by Humpty Dumpty, who said, "When I use a word it means just what I choose it to mean—neither more nor less"; and the fundamental difficulty was equally well stated by Alice who said, "The question is, whether you *can* make words mean so many different things." Humpty Dumpty, always

clear on first principles, answered, "The question is, which is to be Master—that's all." But he was boasting. It would be easy enough to follow his instructions if words were only used once, and it is just possible as long as they are used under severely restricted conditions for a severely limited purpose, as actually happens with technical scientific terms. The difficulty is that words have a history, usually long, often varied, sometimes disreputable. Until a language is definitely dead the words are being used and each time they are used their history grows a little.

There is still another difficulty. A single word is usually a fragmentary symbol, except for exclamations like "Fire!" or "Help!" which are complete in themselves. A sentence may be a complete symbol and grammatically at least it is complete. It is very likely, however, to be part of a larger whole and therefore more or less incomplete. The test, of course, is simply how far it can stand by itself, really convey something to a hearer and convey something not very different from what it conveys in its proper context. The unit of language is properly speaking a complete *discourse*, or something that can stand by itself as a complete symbol. A discourse may be a single word like "Help!" or eight volumes like Gibbon's *Decline and Fall of the Roman Empire*. Within the discourse are the separable signs we call words, which are used over and over again in different combinations. Because they look alike or sound alike whenever we come across them, we are apt to think they always signify the same thing, whatever company they keep. This is true enough of mathematical symbols but it is sadly untrue of ordinary words.

Some logicians would have us believe that we know the meaning of a proposition (or judgment) when, and only when, we know how to verify it by appeal to direct experience. This works well enough for scientific discourse and actually provides a useful method for refuting absurd theories, but it leads to serious difficulties in other spheres. If Messrs. Smith Ltd. say to Messrs. Brown Ltd., as a matter of business, " We owe you 2s 6d.," that may be taken to mean that at some future date 2s. 6d. will be paid over. If it is paid over the proposition is verified and is true, if not, it is not verified and is false. In any case an examination of the firms' books will settle the matter. So far so good, but suppose it is only John Smith talking to Joe Brown. They keep no accounts and whether or not Smith does actually pay Brown is irrelevant to the meaning or even the truth of the proposition. Yet it is ridiculous to say that the proposition is meaningless.

A discourse has two functions, demonstration and suggestion. As far as it is demonstrative it points to facts, actual or possible, particular or general and that is the only function known to traditional logic. Its function is to limit the thought of the hearer to the facts and is therefore negative as much as positive. It is intended to keep the hearers' thoughts from straying away from, disregarding or misinterpreting the facts. The suggestive function is to start going a train of thought or of action which may go on indefinitely. If facts are pointed out it is only incidentally. The suggestive function may still be fulfilled if the facts are not as stated or if there are no facts at all or even if the pointing process is quite indefinite. As suggestive, language is intended to affect human behaviour; it

has the character of a command or a question rather than an assertion.

If somebody shouts "Fire," as demonstrative that "means," or points to, the fact that there is a fire in some particular place: as suggestive it "means" an exhortation to escape from it or come and help to put it out. It would not be correct to say that suggestion in this sense is a function of the emotions and demonstration a function of the intellect because it is only through the intellect, if by intellect we mean the capacity to interpret the signs of language, that the emotions can be aroused. Language that is not understood produces no emotion at all (apart from a vague sense of annoyance). Suggestion is simply a process by which the significates of the primary signs become signs in their turn.

We often speak as though it was an abuse of language to arouse emotion, although that is its original and primitive function. The notion is not entirely unjustified. If the suggestive function preponderates too much over the demonstrative and the suggestion is not to action or to actively imaginative thought but only to phantasy, then thought may be led away from the real world without any route for return. Emotion ought to be a prelude to or accompaniment of action, so that it is not legitimate to arouse emotion that is inappropriate to the actual or probable state of affairs To arouse emotion in a hearer by shouting "Fire!" is legitimate only if there is a fire.

Now you may ask: what has all this to do with the study of mind or psychology? Are these matters of symbolism, of the function of language, part of psychology any more than logic is part of psychology? As to

logic I shall not venture an opinion because I am not sure what logic is. But as to the study of the function of language and the nature of symbolism I am quite sure that it is psychology or ought to be, and that one of the defects of modern psychology is that too little attention is paid to it.

Intelligence and Language

At this point it is necessary to say something about Professor Spearman's work on intelligence,[1] to bring out some further aspects of the function of language. For if there are such things as "Laws of Mind" it is within this sphere that they are to be looked for and they are likely to be very like Spearman's principles of "Noegenesis" even if they are not identical with them. Though some of the things I have to say look like adverse criticism, the substance of the criticism is that the principles have not been worked out and applied as vigorously as they deserve to be.

The first result of Spearman's work has been to introduce order into the chaos of "intelligence" or "mental" tests. These tests as is well known are very like ordinary scholastic examination questions, but differ in certain important respects. They are questions of a simple general type and are usually designed to exclude any appeal to special information or detailed knowledge of fact. Further, they are arranged so that there is unambiguously one correct answer to each question and automatic methods of scoring are used so that the personal judgment of the examiner does not come in. Typical problems set are, to supply

[1] C Spearman, *The Nature of Intelligence and the Principles of Cognition*. 1923, *The Abilities of Man*, 1927

a missing word in a sentence, to detect absurdities in a statement, to supply a correlative term (e.g., snow is to white as coal is to——), as well as arithmetical questions, geometrical and pictorial puzzles. By statistical analysis of the results of large collections of such tests, comparing them among themselves and also with ordinary scholastic tests, Spearman concludes that there are two factors responsible for high scores. There is a general factor (*g*) which determines high scoring in any test and also special factors (*s*) which determine high scores in some tests but not in others. He compares *g* with the total supply of intellectual "energy" the individual has available. The *s* factors are like the engines through which the energy is made available for work The *s* factor's are not the traditional "Faculties" or anything resembling them; beyond that there seems to be little to be said about them, and that little it is not necessary for me to say here. Following on this Spearman has enunciated general laws or principles, three qualitative and five quantitative. It will be convenient, if not strictly logical, to take the latter first.

The first quantitative law is given (*Intelligence*, p. 131) as "*Every mind tends to keep its simultaneous cognitive output constant in quantity, however varying in quality.*" This may be taken as a straightforward generalization from the mental tests; namely, that apart from gradual change with age and accidental variations (e.g., illness) everybody's capacity to score in mental tests, and particularly his *g* value, tends to be constant. There are however three comments to be made. (1) A purely verbal criticism is necessary. In mental tests (or other examinations) it is maximum

output or efficiency over an hour or two that is tested. It does not follow that the candidate's cognitive output is as high when he is sitting smoking in an armchair after dinner. The statement needs qualifying to show that the constancy is maintained under certain conditions only. (2) This is a more serious point and raises a question that is perhaps of no immediate importance but will ultimately need to be settled. Energy in physics can be considered as compounded of an intensity and a capacity factor. Taking the analogy seriously, is it the *total energy*, or the *energy potential* of cognition that is constant? Is *g* measured in *volts* or *watt-hours*? The fact that speed as well as performance varies with *g* suggests that it is "potential" that is measured. Perhaps the capacity factor does not vary greatly from one individual to another or possibly it is connected with the "conative" factor to be mentioned later.[1] (3) In Chapter XIX of the *Abilities* Spearman discusses the phenomena of oscillations in cognitive efficiency, which seem to be quite genuine phenomena though it is not easy to discover how large and how frequent they may be. As a rule a set of tests the results of which are summed will measure an average between maxima and minima of efficiency. The constancy that is found between different sets of tests on the same individual is the constancy of these averages. For many ordinary forms of work it is probably the average that is important. Nevertheless, as Spearman points out, the value of the "intellectual" worker is really to be judged by the height of his maxima when he makes his discoveries or his creative efforts. And in some cases the

[1] Is Spearman's "energy" the same as Freud's "libido"? If not, why not?

" practical " man is to be judged by his minima, when he makes his blunders. There are clearly cases when it is necessary to look beyond the average.

The other quantitative laws do not need so much discussion. The second is that of " retentivity." "*The occurrence of any cognitive event produces a tendency for it to occur afterwards.*" As Spearman shows there are several factors concerned. One is that of " inertia " or " perseveration." This works either way according to circumstances to improve or worsen cognition. It helps a process to persist in spite of distractions, but it also hinders the switching over of attention to a new process. Besides " inertia " there is the factor of " facilitation " and that of " association " which is perhaps distinct. The third law is that of " fatigue." "*The occurrence of any cognitive event produces a tendency opposed to its occurring afterwards.*" Very likely there are several factors involved here too. There are obvious physiological analogies to the second and third laws, but they are hardly worth discussing as they may be misleading and in any case throw no light on the subject.

The fourth law is that "*The intensity of cognition can be controlled by conation.*" The mental tests provide considerable evidence for this, but it does not seem possible at present to say how much effect conation has. Lastly, the fifth, "*Every manifestation of the preceding four quantitative principles is superposed upon, as its ultimate basis, certain primordial but variable individual potencies.*" This resembles those clauses lawyers like to put into legal documents which begin " Notwithstanding ——" and neutralize the effect of everything that has gone before. It means that there are plenty

more variables not yet listed, much less measured, and unfortunately no flaw is to be found in the statement.

Taking these five laws as tentative formulations they obviously point the right way. The value of a quantitative law depends upon the accuracy with which measurement can be made and the extent to which irrelevant variables can be eliminated. In this sphere where all measurement is indirect, laborious, and very difficult, and where it is almost impossible to eliminate irrelevant variables, the really surprising thing is that anything approaching quantitative results are possible.

The qualitative principles however are more important; they are essentially descriptions of types of cognitive process (Noegenesis), while the quantitative laws are concerned with factors affecting the speed or efficiency of these processes. They are formulated as follows (*Intelligence* pp 48, 63, 91).

(1) "*Any lived experience tends to evoke immediately a knowing of its character and experiencer.*"

(2) "*The mentally presenting of any two or more characters (simple or complex) tends to evoke immediately a knowing of relations between them.*"

(3) "*The presenting of any character together with any relation tends to evoke immediately a knowing of a correlative character.*"

Apart from purely verbal points (what is meant by "immediately"?) (2) and (3) are undoubtedly important generalizations. (2) corresponds fairly closely to what traditional logic calls *induction*, assuming that the relation is expressed in general terms, and (3) to *deduction* again assuming the relation is expressed in general terms. The difficulties come with (1), which Spearman himself confesses has not found much

application. It is, I believe, seriously defective, both as bringing in something irrelevant, self-consciousness or "introspection", and as hiding under the word "knowing" at least two different processes that need explaining.

The mental tests consist in presenting the subject with a set of symbols or a symbolic situation which needs completing or correcting, and (2) and (3) describe the principal elements in this process of handling symbols. This covers a large part of cognition but hardly the whole process under all conditions. In particular, the fundamental intellectual process must be the symbolization of experience, as to which the three principles say nothing unless the word "knowing" in the first is held to be sufficient.

Cognition, I suggest, begins with what may be called "articulating" experience, separating, and grouping elements previously confused and indistinct to make them clear and distinct. So far there is nothing that may not be called simply perception or sensation. The next step, and that is the one that is really difficult to do and to describe, is abstracting and generalizing, and it is here that symbolization comes in. A symbol might signify the concrete and particular but its use is to signify the abstract and general. The symbol is a substitute on which the percipient can operate when he cannot operate on the thing it stands for. Thus I can say "The sun will rise to-morrow" whenever I like, without these symbols I should have to wait to point to it rising. The symbol itself is a particular each time it occurs but its particularity is irrelevant. Thus I can write "DOG" or "dog" or "*dog*" or even "chien"; as symbols however they are all alike, they

are abstract and general and what they stand for is also abstract and general; they are not tied down to one dog in one place.

If we are given something already symbolized in words or pictures as in the mental tests, there is an obvious distinction between the symbols themselves on the one hand and on the other their relations or the operations that can be performed on them or with them. This distinction is the basis of the distinction between principles (2) and (3), providing a relation when symbols are given or providing a symbol, given a symbol and a relation. Of course a symbol can symbolize a relation or operation but this complication need not concern us here.

A man's intelligence is not something he carries round in his head independent of everything else about him, but is what it is as arising out of and as applied to his circumstances. It is important therefore to consider more closely what kind of things the intelligence or mental tests may be, in contact with which intelligence has been measured. Tests expressed in words are concerned with the formal or logical relations of language at the level of ordinary everyday use. The other tests are mainly of an elementary mathematical type, concerned with the simple formal relations of numbers and geometrical figures. These are just the things with which the elements of school education are concerned, if pure information and knowledge of fact is left out of account. That is to say the pupils are taught to handle the signs of their own and other languages and mathematical signs in a proper manner with a range and precision depending upon the age and ability of the pupil.

The tests are all concerned with the handling of symbols but at a relatively crude level and the handling of the symbols is supposed to depend upon their logical relations. That is to say they make no appeal on the one hand to the more general, abstract and precise types of mathematical work, nor on the other to the more advanced use of language in its suggestive aspects, as they are exhibited in poetry for instance, but only to the elementary demonstrative or logical aspects. School education and tests do make some appeal to those other aspects of language.

It is not altogether surprising that by the use of tests which appear to set no problems that an intelligent twelve year old could not tackle, it has been found that children of fourteen or fifteen can score as high as adults. Of course the result may be correct in every way and certainly the alertness of children as compared with the obtuseness of adults is such as to make one inclined to believe it. It is nevertheless true that even in the spheres where pure information and accumulated experience are least important, in music, poetry, and mathematics, the great masters have not been as masterly in their teens as in their twenties or in their twenties generally as later on. It may be the case that Spearman's *g* factor as found in tests on children is the central factor at all levels of cognition. It is certainly the factor operating in ordinary communication by symbolic means and therefore must be a large part of what we mean by intelligence. It cannot be proved to be all until tests at higher levels are introduced. These will have to be something very like ordinary academic tests. (There is just a remote possibility that the much derided examinations of the

traditional type do test intelligence after all) Of course " intelligence " may be defined as what is tested by certain specified kinds of tests but that is confusing, to say the least, and a new technical term ought to be invented for this purpose.

I would suggest that there are actually three elements left out in tests of this sort which ought not to be neglected. The first of these has been mentioned already, it is the process of symbolization and generalization of what is not already presented in symbolic terms or not adequately symbolized. This is perhaps *the* creative intellectual faculty. The history of science seems to show that the great advances all come when somebody generalizes what was previously only special data, or provides adequate symbols when they were previously inadequate. The history of mathematics shows these points very clearly, so also I think does that of other sciences in so far as they are not mere accumulations of data. Even in accumulating data, if that depends upon finding a new method, the same principles apply. What the masters do on a grand scale, their humble followers do to some extent on a small scale. This is perhaps all commonplace and it has been implicit in everything anybody has said about cognition from Socrates onwards, but it remains implicit. It will so remain until a clear account is given of the process of symbolization whereby one object and its operations replace another and its operations, so as to give the thinker vicarious control over things.

The second factor that the intelligence tests neglect is that of proof or reasoning. The testee must find the answer that is as a matter of fact correct but is not required to justify his choice. Yet surely all the higher

flights of mathematics depend upon just this process of giving proof or reason of the most general possible type. Mathematicians have always given the highest praise to " elegance " or artistic perfection in reasoning.

The third factor depends upon the relative crudeness of ordinary linguistic use. Mathematical symbolism is an instrument of great precision and subtlety but it operates within extremely narrow limits. Language knows no limits to its sphere of operations but it is not precise and only occasionally subtle. At the level of its use for intelligence tests it is very crude indeed, simply because ordinary words in their ordinary use may not fit the procrustean bed of the test question. Take an example that Spearman himself uses and that is supposed to be of a fairly high standard of difficulty (*Intelligence* p 69). The test is :

Warmth is to *stove* as *sharpness* is to——

fireplace tool heat cut.

The testee has to select from the four words in the second line the correct one to fill the gap. We are told *tool* is correct but that *cut* is sometimes selected by persons of inferior ability. A careful examination of the question suggests that a person of superior ability limited to a choice of four incorrect answers might in despair select *cut.* There is at least a universal connection between sharpness and cutting whereas there is none between sharpness and tools, for many, like hammers and screw-drivers, are not sharp. The most nearly logical answer would appear to be *grindstone,* because that when in action produces sharpness as a stove when in action produces warmth. I need not labour the point further. Ordinary language does not provide strict logical analogies, it only provides vague

resemblances. If therefore intelligence consists in discerning logical relations, language cannot test the higher grades of it.

Let me take another example, a simple one from a crossword puzzle this time. The clue given is "There are no Sappers in this Lightship"; the word indicated is "NORE." Now this is a violation of any logical rules of language symbolism. Does ability to find the answer signify lack of intelligence?

As has been mentioned already language is not purely *demonstrative* or logical, it is also *suggestive*, and its higher flights depend almost entirely on this last function. Puns and tricks of speech like the example given represent a low form of these developments, but one that cannot be ignored entirely. The poetical use of language represents a more respectable development. From the demonstrative point of view Byron's lines:

> "The mountains look on Marathon
> And Marathon looks on the sea,"

are simply a statement about part of the coast of Greece, a statement that can be verified from the map or by going there to see. That however is only a small part of what the writer intended to convey, as is seen from the next lines:

> "And musing there an hour alone
> I dreamt that Greece might still be free,
> For standing on the Persians' grave
> I could not deem myself a slave."

These statements have no *logical* connection with the previous ones. Nor, in spite of appearances, is their main intention to convey information about the poet's state of consciousness. The ultimate aim of these

lines, and the rest of the poem, is to suggest something, first of all as to certain events that occurred more than two thousand years ago and secondly as to events that might occur in Byron's lifetime or later. He wished to produce in the reader a sympathetic emotional state and to set in motion a train of images, one set leading to another in an indefinite series.

By origin the signs of language are arbitrary, in use they acquire "natural" relations. In part these are demonstrative or logical, in part they arise out of the suggestive use of language. Man's social relations are very largely the result of language and chiefly of language in its suggestive or practical aspects. Poetry is simply language operating at a high potential.

The conscious deliberate use of language is not the only symbolic medium for social communication. There are others which Freud and his school have studied. Admittedly this school are too much concerned with finding disreputable motives for harmless acts and they distort the facts to fit preconceived theories, but in principle they are right. Take what is perhaps a trivial instance: J. C. Flugel's book on *The Psychology of Clothes*, a discussion on Freudian lines of the motives for wearing clothes, and clothes of one sort rather than another sort, and of what it is clothes signify consciously and unconsciously in human life. I am not concerned to argue whether the author's conclusions are right or wrong nor whether his use of the Freudian method and philosophy is valid or not. The only way he can be shown to be wrong is by somebody producing a better psychology of clothes. Whether right or wrong the author has attacked a subject which is a proper one for psychology. That is to say a man's

clothes, and still more a woman's, are a part of the expression of his or her personality as a member of society. They are the product of mental activity, of cognitions, desires, emotions and so on. They are symbolic of the person who wears them, of his emptiness of course as well as his fullness. The clothing of a people or of an age is an expression of its " spirit " just as much as its art, science, and literature, and much easier to study critically.

It is worth noticing, in parenthesis, that if literary criticism is to be serious and valuable it should be the analysis with the help of psychological principles of the thought which the author has expressed in writing. That undoubtedly is how Coleridge understood the matter. Notice the avidity with which novelists and biographers of recent years have seized upon the theories of the psycho-analysts. It has been overdone of course as everything is in this age of mass-production, but the novelists' and biographers' hearts are in the right place even when their brains are not. That is to say a new psychological theory does provide new weapons and possibly a new insight into life and letters which the literary man can and ought to use.

Conclusion

From the point of view of the cognitive process consciousness is a primary fact, but a fact that gives us no direct information about the working of our own minds. It may be taken to represent a certain degree of stress in the life of an organism. The direct information we get is about the objects of consciousness, mainly about the external world and the relations of our bodies to it. There are in addition objects which

are mere objects of thought with no discernible relations to material things, but they reveal only themselves except in so far as they stand as signs. It is true that there is self-consciousness. I can be aware that I am aware. The ordinary forms of language disguise the fact that self-consciousness is not a revelation of a definite object capable of leading to general information about its character and relations. Self-consciousness enables us to hold opinions and to talk about our own mental processes, but these opinions are far from infallible. It may lead us to suppose that we are desiring this and indifferent to that, hating this and loving that, believing this and doubting that. These suppositions cannot be accepted as valid unless they are checked from other sources. If we are to discern definite facts and draw useful general conclusions we must go to those aspects of experience which bear scrutiny and analysis, namely what happens in the external world of things and persons I myself in my bodily capacity am one among them and if I consider myself *primus inter pares* it is only in a strictly spatial sense as the nearest object, the most familiar object not always the best known.

The mistake of the Behaviourists is not so much refusing to take account of consciousness as refusing to take account of any facts except those revealed by a special kind of laboratory technique. The evidence obtained by their methods is biased and incomplete and resembles too much confessions of crime obtained by torture.

While self-consciousness as such does not give reliable information about our own mental processes, it is as conscious that we are cognitive and as cognitive that

we distinguish ourselves as individual embodied minds distinct from their surroundings. Cognition though is concerned with the objects of consciousness and not with acts of mind.

The most central and illuminating fact of mental life is not consciousness but freedom. The fact that, within limits, we may be autonomous, that we are capable of action which is our own and not imposed entirely from outside by chance or necessity. The conception of freedom is difficult and it is easy to talk nonsense about it, but to deny it is inevitably to talk nonsense. Not only is freedom compatible with causality, but the two notions are closely connected. This has been put epigrammatically as " Determinism is Free Will expressed in the passive voice."[1] Unless you accept freedom as an initial postulate it is no use talking about mind or trying to distinguish the higher from the lower among living organisms or even talking about organisms at all. None of these would be distinguishable but for their display of something like spontaneity, initiative or choice, as far as their limitations permit. It would be no use to speak about causation even, because the notion of a cause as some change initiating other changes depends upon accepting the fact of human volition as the typical causal process.

It is notorious that in civil life " the price of freedom is perpetual vigilance " and it is equally true in personal life. Freedom is not only difficult to conceive in intellectual terms it is also difficult to preserve in actuality. Behaviour tends to drop from the voluntary level to the involuntary level. For this reason there are two kinds or aspects of freedom. In the first sense

[1]Hobart, *Mind*, January 1934.

freedom means merely choice in action. In the second it means reasonable choice. Unreasonable choice is free at the moment but in the end it limits or destroys freedom.

The life processes of the *psyche* go on at a series of different levels. At the lower levels they grade off into the various separable physical processes of the bodily organization. At the higher levels they are united into what should be the harmonious and free life of the human individual. In the end then the study of mind is the study of man's behaviour in his environment, an environment that consists of other persons before it consists of things. Our first act after birth is a cry for help and our last act before death is likely to be the same. We cannot live except by the help of our fellows.

If the behaviour of men is explicable at all the explanation must be mainly in terms of social factors. If a man behaves in this way and not in that, it may be because he has stumbled over a stone, but it is more likely to be because of something that has occurred in his intercourse with his fellows. What he says about the matter is part of the evidence but not necessarily because of its truth or its immediately apparent relevance. In principle Freud is right however wrong he may happen to be in detail. A man's conscious thoughts and voluntary acts ought to be a complete exposition of his person and so they would be if his personality were completely and harmoniously integrated. Where as often happens this is not so it is necessary to examine as far as possible unconscious thoughts and involuntary acts.

As far as thought is concerned, and at any level of

thought, it is a symbolic process. It is mental not because the symbols are immaterial, for they are often material perhaps always material, but because they are symbols. The function of thought is to liberate the individual from his immediate environment to give him contact with remote elements of environment. Thought is reasonable or intelligent in so far as the liberating process is successfully directed to what are genuine factors in the world of men and things and not mere fantasies.

The essential act of thought is symbolization, making one object (the sign) stand in the place of or be equivalent to another (the significate). The act may be involuntary, the result of habit, or it may be a deliberate act of will. Sign and significate may have some natural or pre-existing relation. They may resemble one another, they may be related as cause and effect, they may occupy identical or contiguous spaces and times. On the other hand they may have no natural prior relations ; their relation may be arbitrary.

Symbols deal immediately with the general and not the particular, with relations rather than the individuals related. In strict reasoning what is made use of is not the content of the symbol but its relations to other symbols. That is why arbitrary symbolism is so specially useful for mathematics, the natural relations of symbols that are not arbitrary tend to get in the way of the purely formal relations. The signs of spoken language are mostly arbitrary in origin, unless all words begin like " bow-wow " and " puff-puff." The written signs are quite arbitrary. With use and the lapse of time symbols acquire " natural " relations. Words are in a sense living organisms and differ in this respect

from mathematical signs which are of necessity quite dead. It is this that makes language the despair of logicians and the delight of poets.

If the "group mind" were anything but a misleading metaphor, the life of that mind would live in language and other symbols, in the literature, science and art of the group. Otherwise it is only a name for the rage and panic and senseless excitements of the herd. Though the group mind may be dismissed as imaginary the minds of the individuals cannot. It is customary to think that these minds live their life within the confines of their own bodies and that all the rest is merely the inorganic world. Is it not nearer the truth to say that the individual minds live, in part at least, where the group mind would live if there were such a thing? They are not only the separate bodies they animate but the social relations they maintain, the science, art, literature and all the other symbols and instruments that make up civilized life—as far as we are civilized.

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